

Concrete

Vol. 24

Detroit, March, 1924

No. 3

The Work of the American Concrete Institute

BY HARVEY WHIPPLE
Editor CONCRETE

THE 20th annual convention of the American Concrete Institute in Chicago, February 25 to 28 was conspicuously successful. A convention is probably conspicuously successful when it brings together a considerable number who are working in one general cause, in many different ways, and sends them home with ideas which can be applied to that general cause in the many different ways of their diversified callings.

From a purely organization standpoint, the progress of the Institute is to be measured in the degree and in the character of the recognition which has come to the organization of its high purpose and its practical and energetic usefulness. Such recognition does not come to an organization except by contagion. Nothing succeeds like success. The fact that the Institute is founded on the lively interest in better concrete of a body of men who are in one way or another *making* better concrete, as a result of that lively interest, is the strongest possible magnet. So, in a little more than four years the Institute has grown from less than 400 to more than 1250 members and by its activity in the many different directions, which lie within the broad comprehension of "Better Concrete" makes a place for every man whose business or professional growth answers to that shibboleth.

Five hundred seventeen were registered for the Institute meetings, most of which were well attended and 286 sat down to the banquet which topped off the special 20th anniversary celebration program of the 27th. This was good attendance and probably justified the labors of the unusually numerous Institute workers who gave so much of their time in the preceding weeks and months to make this 20th annual meeting of special significance and value.

Measured in still another way the meetings were successful. The influence of such an organization as the Institute may be diagrammed as in concentric circles. A few men stand close to the center, the bull's eye; these few know pretty much all of what has gone before; they have absorbed most of this knowledge and translated it, in some measure at least, into action. It is difficult in a convention to give to these few a great deal that is worth while. What little strictly fresh

information they do gather from such a meeting is, however, of proportionately higher value from the fact that they are in the best practiced position to utilize fresh knowledge.

Surrounding these few men near the bull's eye is a slightly larger group, who, having less or narrower experience, or not yet having translated into practice quite all of the wisdom of the center group, have a bigger opportunity to gain intimate understanding of sound theory and good practice.

Outside these is another circle and outside this still wider circles. Of course, no such arbitrary lines can actually be drawn among the organization's members, yet in a big, average way such are the classifications to be considered in relation to the policies and the programs of the American Concrete Institute.

Only at intervals can the wise few hope to add something to their store. To be successful then the American Concrete Institute must so arrange its activities that there is a constant movement of its specialized membership from the circumference toward the center and from entirely outside its various concentric areas into the outer circles. That is the scheme of technical organization growth. First one must want to *know* more and have the will to *do* better. As he comes into the outer circle, with many like himself, he learns from the next concentric group and after a while he steps unconsciously over an invisible line of progress. Constantly he makes new contacts with knowledge and so moves toward the center. The center no one will ever reach because perfection is not to be attained. It is an illusory objective. It is wholly imaginary.

The point of all which seems to be this: The Institute must always be repeating itself for the newcomers. If it confined its reports and its discussions to those things which would constitute fresh knowledge to a favored few of high technical attainment, its usefulness would still be great but its influence vastly curtailed. Instead, we find it serving all along the line. It has for its object not only the perfection of the highest knowledge we have, which is the work of a few, but the more widespread acceptance of intermediary stages of knowledge by which we may all approach our goal of higher efficiency and greater usefulness.

The Past and the Future of Concrete

An abstract of concluding address by Richard L. Humphrey—20th Anniversary Program, American Concrete Institute.

It is apparent from what has been said to you today that the art of reinforced concrete is quite young. It is less than three quarters of a century since the first experiments on embedded metal in concrete were made. Less than half a century ago the first house was built, and it is but a little over a quarter of a century ago that more pretentious structures were undertaken.

This is indeed a short time as contrasted with the life of ancient Roman structures, surviving remnants of which tell the story of mortars and concretes used more than 2000 years ago.

What a wonderful record the surviving structures would tell of the ancient art of building construction, if a material having the durability of the present American portland cement had been used.

The century that has elapsed since Joseph Aspdin obtained his patent for making portland cement is but a brief space as measured by human accomplishments, and yet in that time there has been a tremendous development of the use of this material in building construction. It is not improbable that the production of cement in this country during the past year was greater than all that was ever used in Imperial Rome.

The great future of concrete lies in its intrinsic qualities as a building material, and in the ingenuity displayed in devising mechanical appliances by which it may be economically mixed and placed.

In the nearly twenty years that have elapsed since this Institute had its birth, the increasing knowledge of the properties of concrete and its application has been reflected in the transition from heavy massive structures to lighter and more artistic ones. The early conditions in this country surrounding the use of concrete, namely, cheap materials and relatively high cost of labor, made it economical to use materials and save the labor of form construction which would have been necessary in reducing the mass. In Europe, the conditions were just the reverse, and the effort was to economize in the use of costly materials; concrete was eliminated where not structurally required, and there resulted lighter-appearing and more artistic structures.

The development of the American Concrete Institute had kept pace with the growth of the industry, and, as the latter acquired stability and permanence, the Institute has also acquired stability and a standing that places it beyond that critical period when its continued existence was in doubt.

To those pioneers who guided its earlier destinies, its present position is most gratifying; and the relief felt has all the zest that one experiences in the winning of a hard race.

If we could look beyond the veil of time into the future, what a vision we would behold; Aladdin's

lamp would be nothing to the magic that had been wrought by portland cement. The tremendous increase in the consumption of portland cement is beyond the dreams of the most sanguine, and the end is nowhere in sight. Bold indeed is he who would foretell the use of portland cement of that future period. But, while pondering the probable future, there unfolded before me one evening the wonderful panorama of the future City Beautiful of Concrete, artistic, unburnable, indestructible.

The problems of our day had been solved—statuary and other works of art, formerly carved from perishable marble, were molded in concrete, and had a texture equal to that of any stone—capable of taking an enduring polish; manufactured by scientific formulae resulting in a uniform standard material free from the unsightly flaws of stone formed by the less scientific processes of nature.

Lumber had been replaced by boards, posts, joists and other structural forms molded from reinforced concrete of light-weight aggregate, into which nails could be driven, having strength greater than wood, with the highest resistance to fire and the action of the destructive agencies.

Barges and ships; freight and passenger cars; battery cells; radio, telephone, and telegraph poles and masts; sewer and water pipes, drains, conduits, and culverts; retaining walls, bridges, and arches; piers, docks, and quay walls; pavements and curbing were all built of concrete.

The movement for decentralization of congested centers of population had become effective, and, with the marvelous facilities for communication, travel by air, radio, wireless telephone and telegraph, the need for dwelling in thickly populated centers had disappeared. By reason of this decentralization and the use of concrete in building construction, the losses from fire and the burdensome fire insurance had become almost negligible.

The light-weight aggregate reinforced concrete had opened up new fields of use; its elastic properties and strength replaced the formerly used lumber and steel; its resistance to fire, and its durability and the minimum expenditures for maintenance had resulted in its use for purposes not heretofore contemplated. Cinder partition blocks and slabs had replaced the materials formerly used because of their insulating value, fire resistance, and the facility with which they could be applied.

The researches that had been inaugurated both in Europe and in this country had developed a cement that was as superior to portland cement as it had been to the ancient Roman cement. This new material offered a maximum resistance to sea water and alkali action.

The elastic properties of concrete and the laws of proportioning and mixing it had become so well understood that its structural application was well beyond the wildest present-day fancies. Graceful, artistic arches of great span were now built of concrete.

Progress in Cement Manufacture in 20 Years

By F. W. KELLEY

PRESIDENT, HELDERBERG CEMENT CO. AND OF THE PORTLAND CEMENT
ASSOCIATION

Presented as part of Symposium on Progress of Concrete Construction in 20 years at 20th Annual Convention, Chicago, February 27, 1924.—By courtesy in advance of copyrighted *Proceedings*, Vol. 20, American Concrete Institute.

The efforts of man to find a binding material for use in building started with the prehistoric Better Homes movement, when primitive man moved from the most desirable cave to the detached villa of mud or of stone. Imposing monuments to his deity also needed a binder.

Large deposits of siliceous clays containing alumina are widely distributed throughout the world, while lime exists in some form wherever the seas have covered. Man found, probably by accident, that one, or better still, both of these materials were desirable chemical elements in a satisfactory binder.

In the production of these binders, heat has been used, first in the early sun-dried muds, later in the moderate temperatures needed for burning lime and for natural cement, and finally in the white heat required for making portland cement.

In the use of all these binders or cements, water has been essential.

It is a long and interesting history, upon which we can only touch lightly.

The Egyptians used as mortar in the great pyramids, gypsum binder made by lightly burning the crude gypsum rock of which the blocks in the pyramid are composed. This would be satisfactory only in a climate like that of ancient Egypt.

The Romans added to powdered lime a siliceous material of volcanic origin, and gave to the mixture the name of puzzuolanic cement.

The English burned and ground what were known as "Septaria Nodules," containing lime and silica, dredged up in certain localities, and called it "Roman" cement.

Natural cements were produced in many countries from natural rock, which experience showed was of suitable composition, by lightly burning it to drive off the combined carbon dioxide and grinding it to a coarse powder.

It was not until Smeaton's investigations about 1756, in connection with the rebuilding of the Eddystone lighthouse, that the records show some knowledge of chemistry, and of the reason for the property of hardening, both in air and in water, possessed by the so-called hydraulic cements, containing both lime and silica with certain other materials.

In October, 1824, nearly one hundred years ago, Joseph Aspdin, an English bricklayer, took out a patent on what he called portland cement. As is well known, the name Portland was given because of the similarity in color of this cement, when set, to the building stone quarried on the Isle of Portland, England. Aspdin did not understand the reason for the results which he obtained, and it remained for Isaac

Johnson, also an Englishman, to develop and perfect methods by which a uniformly reliable product could be obtained.

The definite control of the raw mix, and the extreme high temperature of burning, which distinguish portland cement manufacture, were now brought into practice for the first time.

The production of portland cement developed rapidly in England from about 1850, spreading about the same time to the Continent, where it made marked progress in both Germany and France.

In the United States, portland cement was imported until about 1872, when its manufacture was begun on a very small scale. A number of attempts were made in widely separated places to get the required results, under the conditions existing in this country.

Portland cement manufacture as then practiced in England and upon the Continent, used as raw materials principally soft, finely divided muds and clays, having the necessary chemical constituents. These materials were molded into brick, which were burned in vertical kilns, and when cooled were hand sorted and ground to finished cement.

In the United States there was little or no raw material of the European kind, while the relatively high cost of labor made the European methods of handling too expensive. American raw materials required the development of grinding machinery which could economically reduce hard rock to the extreme fineness required in preparing the raw material for portland cement manufacture, while American economic conditions forced a method of burning which eliminated hand labor. American inventive genius solved the grinding problem, while the burning was accomplished through the use of the rotary kiln. This device, invented in England, was perfected and put into practical use in this country.

The development of the portland cement industry in the United States has been largely due to five factors:

First. The systematic application of chemistry, making possible the use of many different kinds of raw materials, all having the necessary chemical composition.

Second. The development of efficient grinding machinery to reduce hard raw materials to proper condition for the raw mix.

Third. The development of the rotary kiln producing a uniform, well-burned clinker with relatively cheap fuel, and eliminating hand labor.

Fourth. The development of standard specifications, establishing minimum requirements for the product; permitting its manufacture from widely different materials, in places reasonably near to centers of consumption, and insuring a reliable cement, at all places, at a reasonable cost.

Fifth. The systematic study of the best uses for concrete, and best methods for making it, thus insuring as far as possible, the most economical and satisfactory results to users.

The manufacture of portland cement, as carried on in the United States, is an exact chemical-mechanical

process, in which large quantities of raw materials are first combined in the right chemical proportions, and are ground to extreme fineness. The proportioning of materials is accomplished in machines, under the constant control of chemists. The grinding is generally done in several stages by machines, each suited to the particular kind of material handled and to the fineness to be reached.

The raw materials, when prepared and standardized chemically and physically, are in all cases fed to rotary kilns. These are steel cylinders, rotated slowly about their axes, which are inclined slightly from the horizontal. The raw material fed into the upper end of the kiln, through the action of gravity combined with rotation, slowly works its way toward the lower or discharge end, meeting the hot gases of combustion from the flame of a mixture of powdered coal and air, which is constantly blown through the hood, covering all but a small aperture in the lower end of the kiln, through which the hot clinker is discharged. In some places, oil or gas is used instead of pulverized coal.

The effect of the hot gases upon the raw material is first to drive off the moisture and carbon dioxide. Next the materials slightly soften and roll into balls of a size between that of small bird shot and that of walnuts. These nodules finally reach the white-hot zone, where the coal flame maintains a temperature of about 2800° F. At this point, a chemical change takes place in the nodules, which up to this time have been a mechanical mixture, and a new material, known as portland cement clinker, is formed.

The slightly cooled clinker, upon issuing from the kiln, passes through some form of cooling device, and is then ready for the final grinding, which reduces it to the fineness of portland cement of commerce.

It should here be noted that, in order to secure the temperature necessary for burning, plants using coal must maintain a separate grinding department, in which a large quantity of highly volatile bituminous coal is handled, dried and ground to extreme fineness, so that, when blown into the kiln with a suitable proportion of air under pressure, it will at once provide the intense heat required to produce the chemical change which gives to portland cement its ability to harden and meet the strength requirements of the specification. The quantity of coal, or its equivalent, needed to produce a barrel of portland cement in most plants approximates half the weight of the cement.

The cooled clinker is generally reduced by two stages of grinding to the fineness required by the specifications, so that at least 78% of the product will pass through a sieve having 40,000 meshes per sq. in. This sieve is finer than most silks, and will hold water. In the final stage of grinding, a small quantity of gypsum is introduced with the clinker, to insure a setting time which will make the resulting concrete convenient to handle.

The finished cement is carefully sampled and tested, to insure full compliance with the specification requirements, and is held in bulk in large storage bins until placed in weighed packages for shipment. In most plants, very large storage capacity is provided, to care for variation in demand due to seasonal or other causes.

There are over eighty distinct operations required in many plants to produce portland cement, although it should be understood that scarcely two cement plants are alike, since each has been designed to take its particular raw materials, and by means, which are as diverse as the materials, reach a substantially uniform end.

Rock used for making portland cement is drilled by power drills and shattered by explosives. The rock

and other raw materials are generally loaded by steam or electric shovels on cars and conveyed to the crushers. Coal is handled and stored by cranes or mechanical conveyors of some type.

Huge crushers, built on the principle of a nut cracker and exerting an enormous pressure, accomplish the reduction of rock or other hard material, while machines, operating on the principle of pounding and rubbing, pulverize the several materials through the remaining stages to their final condition of impalpable powder. The initial crushing machines are generally slow speed, while the pulverizing machines may be high speed, when of the mortar and pestle type, or slow speed when of the ball and tube mill type. Similar types of machines are used for similar reductions in size, of raw materials, of coal, and of finished cement.

The method of handling the raw materials with water differentiates the wet process from the dry process of making cement. Coal and clinker grinding operations are the same in both processes.

The rotary kiln, which has been described, sometimes reaches a size equal in diameter to a standard Pullman car, and in length equal to three such cars, placed end to end. Some of the grinding machines weigh, with their load of grinding elements, as much as a large locomotive. The mechanical conveying devices used for transporting the materials, horizontally and vertically, include belt, pan, and screw conveyors, bucket and pan elevators, cranes, hoists, cableways, drags, skips, cars and compressed air.

The cement when forwarded to the user is packed and weighed in pre-tied bags of special construction, and is only touched by hand when placed in the freight car, truck or boat for shipment.

Large amounts of power are required for the several grinding operations. The portland cement industry is one of the three industries of the United States using most power per dollar value of product.

A well-equipped machine shop is an essential part of every cement plant, since the abrasive character of the raw materials and of the finished product, which is capable of scratching glass, causes a very high rate of wear and involves large repair costs.

The capital investment in plant is high, the capital turnover is slow, and manufacturers have had to rely upon a large volume of business to make profits on this commodity, which sells at a pound price lower than any other highly manufactured article.

In 1890 there were 16 plants in the United States, producing a total of 335,500 bbls. per annum, or an average per plant of about 21,000 bbls. per annum. In 1900 the number of plants had increased to 50, the total production to 8,482,000 bbls., and the average plant production to 175,000 bbls. per annum. In 1903, just before the establishment of the American Concrete Institute, the number of plants had increased to 78, located in 19 states, the total production being 22,342,973 bbls., and the average plant production 285,000 bbls. per annum. In 1922 the number of plants was 118, in 27 states; the production 114,789,984 bbls., and the average per plant 972,000 bbls. per annum.

In 1923 the total production was about 135,000,000 bbls., or 369,000 bbls. per day. This daily output is greater than the annual production in 1890.

The average output per rotary kiln in 1921, which is the last year for which official records are available, was 133,000 bbls., compared with 85,000 per kiln in 1910.

It is estimated that the cement plants in the United States used, in 1922, over 8,500,000 tons of coal, 4,400,000 bbls. of fuel oil, and 3,400,000,000 cu. ft. of gas.

CONCRETE

There are probably over 200,000,000 cloth sacks in service handling cement today. Over 50,000,000 sacks are lost or destroyed per annum. A strip of cloth, 28 miles long and 30 in. wide, is needed to replace them. Over 18,000,000 paper sacks were used during the year. Over 32,000,000 lbs. of lubricants were used.

For the kiln linings, over 4,500,000 fire brick were needed, over 1,700,000 lineal feet of belting were worn out, over 15,000,000 lbs. of explosives were used, and over 600,000 tons of gypsum were consumed.

The consumption of cement in the United States in 1903 was at the rate of .276 bbls. per capita. In 1923 this consumption was about 1.20 bbls. per capita. In 1922 there were 7 states in which the per capita consumption averaged 1.66 bbls. per person. The consumption in the country in 1923 was at the rate of about 450,000 bbls. per working day, 45,000b bbls. per working hour, 750 bbls., or 5 carloads, per working minute, and 12 bbls. per working second.

In 1923 the cement industry accounted for about 3% of the tonnage moved by the railroads of the United States.

In 1903 the world's production of portland cement was estimated at about 66,000,000 bbls., of which the United States produced about one-third.

In 1923 the estimated production for the world is:

	Barrels	
United States.....	135,000,000	50.2%
Germany and Austria....	48,000,000	17.8%
British Empire.....	30,000,000	11.1%
France and Colonies.....	20,000,000	7.5%
Japan.....	12,000,000	4.5%
Belgium and Colonies....	6,000,000	2.2%
Others.....	18,000,000	6.7%
Total	269,000,000	100.0%

The quality of portland cement manufactured in the United States has constantly improved. The extreme 200 mesh fineness of today, noted above, has superseded the coarser product, which 30 years ago was measured only by 50 and 100 mesh sieves, and even 20 years ago the 200 mesh sieve was just about to be recognized.

The present strength requirements of 200 lb. at 7 days and 300 lb. at 28 days for 1:3 sand tensile briquettes, are not only much higher than formerly, but are measured by methods which make the real increase in strength requirements at least 10% more than shown by the figures.

Thirty years ago 1:3 mortar strength of 65 to 80 lb. at 7 days and 100 to 200 lb. per sq. in. at 28 days were considered reasonable. Twenty years ago 150 lb. at 7 days and 220 lb. at 28 days was the requirement of the U. S. Army Engineers.

The requirements which make up the specification were added from time to time, as experience showed that a cement which met the requirements gave good results in service. More recently most of the specification requirements have been checked by careful laboratory research. A cement which meets the specification requirements will give good results if used right.

There has been also a marked improvement in the care and thoroughness of manufacture, and in the resulting uniformity and reliability of product. A requirement for membership in the Portland Cement Association is that members' product must be guaranteed to meet the standard specification.

Portland cement, as manufactured in the United States is the result of the accumulated experience of a century, refined by modern scientific methods of control and manufacture, and tested by time.

The portland cement manufacturer deals with elemental forces. The force required to reduce the rock to a condition approaching its elementary fineness must overcome the enormous earth pressure which compacted these rocks in past geologic ages.

The temperature of burning, which is among the highest known in large-scale manufacturing operations, approaches the point where matter ceases to retain the forms with which we are familiar, and flashes forth as the flaming gases we see in the stellar cosmos.

Quite appropriately out of this play of elemental forces there emerges a product—portland cement—which gives to man a creative power.

In itself cement is only potentially useful. It cannot practically be separated from its use. It cannot use itself. Man must use it, and anybody anywhere may attempt to use it.

This fact has been a determining one in the work of the cement manufacturers of the United States, who maintain the Portland Cement Association, an engineering service organization, national in extent, with 28 district offices placed near centers of consumption. Through its Structural Materials Research Laboratory and its field men, it is in a position to know the best practices in concrete construction, and it gives freely, advice and assistance to all who ask it.

Any man in this country can, without expense, learn how to use cement right. Careful attention to details and personal inspection are needed to insure that the right methods are followed in concrete work. The use of cement is both a science and an art.

Cement has been called the magic powder or the magic of concrete, and, like the Jinn or Genii of the Arabian Nights tales, it requires careful control by its master if it is to behave properly. The cement manufacturer captures the Genii and locks him in the powder made from portland cement clinker, handing the key to the cement user in the form of water. He who uses this key assumes a responsibility which cannot be shirked. Instantly a tremendous force is unlocked. The everlasting grip of the Genii begins to envelop the materials nearest at hand, and for all time there is reflected in the resulting concrete the knowledge, care and thoroughness of the user, in these first few hours after the force is released. The user must supply proper aggregates and water, and use proper methods for mixing, placing and curing. He must help the Genii get the right kind of grip upon the right materials.

The quality of the concrete produced has a significance beyond that of the structure of which it is a part—it is a test of the man who created it.

The American Concrete Institute grew out of the natural desire of cement users to compare experiences in the use of cement, and to profit from them. The Institute can be a most important factor in promoting the right use of cement and concrete.

The continued expansion and development of the cement industry in this country depends upon the general adoption of the best methods for making concrete.

*A digest account of the
Institute Convention begins on
page 113. Other convention
material appears on pages 83,
84, 85, 88, 91, 93, 96.*

What We May Expect to Do With Aluminate Cement

Based on Costs and Results Obtained Abroad

BY HENRY S. SPACKMAN

Presented at 20th Annual Convention, Chicago, February 27, 1924.—By courtesy in advance of copyrighted *Proceedings*, Vol. 20, American Concrete Institute.

My first impulse on reading the letter asking me, as the American discoverer and patentee of aluminate cement, to talk to you of these cements at this meeting was to decline. It seemed too much like asking a fond father to express publicly his dreams of his son's future when the boy was still in swaddling clothes. But on re-reading, I notice the saving words at the end of the title, "based on the costs and results obtained abroad." This let me out. It was not of the infant American industry I was to talk, but of his big cousin, that lusty, thriving, still-growing young giant, the French aluminate cement industry, which has established a right to demand your serious consideration of its product by twelve years' use in all fields of construction and four years' use under the trying conditions of modern warfare. I am not going to try to tell you what aluminate cement is from the chemical standpoint, or to explain the scientific reasons for its high strengths at short periods and its resistance to attack by sea water. Instead, I shall confine myself to statements of what it has done and will do in actual work.

Aluminate cement has two exceptional qualities that differentiate it sharply from all other hydraulic binders. These are the rapidity with which it attains maximum strength and its resistance to chemical attack by sea water and waters containing sulfate of the alkaline earths in solution. We will consider first the remarkably high strengths of aluminate cement at short-time periods, that is, at 24 hours, 3 days and 7 days. In this development of high strength at early periods, aluminate cement is as superior to portland cement as portland cement is to natural cement, or natural cement is, in turn, to lime. The difference in the rate of hardening between aluminate cement and other hydraulic cements is as great relatively as the difference in time of traveling between the ox-cart that brought our forefathers to Chicago and the Pennsylvania Limited that brought some of you here. Aluminate cement concrete mixed one cement, two sand, four stone or gravel, will give at 24 hours a resistance to compressive stress of 2,000 lb. per sq. in.; at 3 days, 5,000 lb. per sq. in.; at 7 days, 6,000 lb. I am not referring now to strengths developed in laboratory tests, but to the strengths you can safely count on getting in the work using average aggregate and workmanship. What does such early strength mean to the worker in concrete? It means that a concrete road can be opened to traffic 48 hours after pouring. For example, at Le Teil, France, a section of concrete road poured between 8 p.m. Saturday and midnight was opened to traffic early Monday morning, and carried a 5-ton tractor hauling heavy loads without marking the concrete. At Lausanne, Switzerland, a bridge was opened to traffic 48 hours after the con-

crete was poured. A 12-ton tractor passed over the bridge the first day without the slightest injury. These early strengths also mean that in reinforced concrete work you can pour a story one day and use the forms again three days after. This was done in the construction of a round house for locomotives at Bethune, France, for the Railroad Company of the North. L. Peulabeuf, the contractor, used aluminate cements. The design called for the construction of 150 concrete chimneys, each 23 ft. high, and weighing 4500 lb., carried by a reinforced concrete roof and girders which had a 20-ft. span. The forms for both roof and chimneys were removed 48 hours after pouring. Using portland cement, the forms and supports had to remain in place 20 days. It is proper, however, to state that French portland cements are slower hardening than American.

In reporting the use of aluminate cement for the construction of a reinforced concrete building at Chateau Roux, Indre, France, M. Blanchett stated that the forms were removed in 48 hours from the beams and 3 days from the girders, and that a saving of two-thirds of the form lumber that would have been required for doing the work with portland cement was made.

Aluminate cement also makes possible the use of reinforced concrete in the structural alterations of occupied buildings. In such work, aluminate cement can be used with the same facility as structural steel. Perret Freres, of Paris, were entrusted by the Bank La Societe Marseillaise de Credit with the alteration of a five-story building on Rue Auber, Paris. It was proposed to substitute for a maze of small rooms and passages on the ground and second floors, the large reception halls and offices of a modern bank. In visualizing the problem, you must realize that the partitions were all masonry, extending up from the cellar and carried the superimposed load of the three upper floors. To make the task more difficult, it was stipulated that the work must be carried on without interrupting the labor of the office force working in these two stories, and without inconvenience to the tenants who occupied the three upper floors. Structural steel columns and girders could not be used, because it would have been impossible to get them into the building and put them into place without interfering with the occupancy of the two lower floors. Reinforced portland cement concrete could not be used, because it would have necessitated the leaving of the forms and supports in place for several weeks in the office space required for the employees. Recourse was had to aluminate cement, which met the requirements of this difficult situation in every particular. Forms were removed in 48 hours, and, by reason of its greater strength, a considerable reduction was made in the area of columns and depth of girders.

Actual use in winter work has shown that the hardening of aluminate cement is less affected by low tem-

CONCRETE

peratures than is the hardening of portland cement concrete. The French claim that, provided the concrete is kept from freezing when it is being put into the forms and for two or three hours after, the development of strength will not be retarded by cold. The heat given off in setting being sufficient to prevent freezing. Whether this would be true in the severe cold of our northern winter is doubtful to me, but the ability to harden at lower temperatures than portland is a great advantage for late fall and early spring work, as it will obviate the annoying condition that most workers in concrete have met with from time to time by having concrete, though unfrozen, lie inert in the forms for days because of the low temperature of the concrete, even though the temperature of the air is quite high. The manufacturers of concrete products find the rapid hardening of aluminate cement concrete of great advantage. It reduces the number of molds required, does away with expensive storage sheds for curing the product, and the tying up of capital in products under process of hardening. The concrete products can be shipped 24 hours after casting. It also permits the manufacture in the field, and the almost immediate putting into use of such products as water pipe, reinforced piles, poles for support, electric wires, etc. Reinforced concrete piles can be driven 3 days after casting, and water pipe put under heavy pressure in 48 hours.

It will probably be interesting to you at this point for me to discuss the relative difference in cost between aluminate and portland cement concretes. According to the best information I can obtain, aluminate cement in France sells at the mills for between two and a half and three times the price of portland cement. This means, allowing on the average \$1.00 per bbl. for handling, that is, railroad freights, hauling, etc., that aluminate cements cost delivered on the work from two to two and a half times as much as portland cement. For example, if portland cement cost \$2.00 f. o. b. mill, and aluminate cement \$6.00, with the addition of a handling cost of \$1.00, the cost delivered on the job will be \$3.00 for portland cement and \$7.00 for aluminate cement, which is two and one-third times the cost of portland. At first thought, such a difference may seem prohibitive to you, except in special cases where the time element or resistance to chemical attack makes the question of cost negligible. Such, however, has not proved to be the case in France. The best evidence of this is that it is today impossible to buy aluminate cement anywhere in Europe for immediate delivery. All the mills manufacturing aluminate cement are over sold. It is more difficult to obtain exact cost data than information regarding the behavior on the work. Therefore, I can quote only general statements.

Mr. Blanchett writes: "One sees that without mentioning the quickness of the process, that the economy realized in the forms makes up and more for the higher price of aluminate cement."

Mr. Louis Peulabeuf writes: "I believe that aluminate cement will be the cement of the future for reinforced concrete work, when its price will permit one to employ it in a more general fashion. Nevertheless, for the present, in spite of its high price, if one takes into account the economy in forms that it permits one to make, there will be found a large compensation for its cost."

Edwin C. Eckel, who made a study of the aluminate cement industry in France during the past summer, writes in December (1923) *CONCRETE*: "The apparent disadvantage, its necessarily high cost per barrel, is only apparent, for aluminate cement whatever its cost per barrel makes a cubic yard of concrete harden

in place at a lower cost than any other cement, owing to the economies possible in proportions, labor, forms and time."

Following the same line of thought as Eckel, Prof. Paris, of Lausanne, has made a series of calculations which show that at current prices in Switzerland, the cost per 100 lb. per sq. in. resistance at 28 days in concrete is less for aluminate cements than for portland. At shorter periods, three days, for example, the cost of 100 lb. per sq. in. of resistance to compression with aluminate cement is one-third that used in portland.

Aluminate cement is no longer regarded as new or experimental in France. It is considered competitive with portland in much work, and, in addition, has a recognized though constantly expanding field of its own, in which the specification of aluminate cements for work is considered almost mandatory. They are used in the largest work, for example, the tunnel at Brauss required some 75,000 bbls., and practically all the cement work used in Paris for street work is now aluminate cement.

Aluminate cement, however, has a quality even more valuable than the development of high strength at early periods, that is, resistance to chemical attack of waters carrying sulfate salts in solution. Extended laboratory research and results of use have proved beyond question of doubt that portland cement is not stable in sea water, many portland cement concrete structures exposed to the action of sea water have been and are giving good service. This resistance to the destructive action of sea water is not due to any particular virtue of the cement used, but to the protective action of the aggregate which prevents the sea water from coming in contact with the cement. Any portland cement concrete, exposed to sea water, sufficiently porous to allow the sea water to penetrate it, will inevitably be destroyed by chemical action, and what is true of sea water is equally true of ground water impregnated with sulfate salts of the alkaline earths. Therefore, the importance of resistance to chemical attack is not confined solely to marine structures. Indeed, the ground water of many of our large cities is contaminated by sulfur. In Philadelphia, this is particularly noticeable. I have known the sulfur content of the ground water to prevent concrete from hardening in deep foundations for two or three weeks. What the ultimate effect of this sulfur on the durability of the foundation will be is not difficult to predict.

In Europe, owing to the character of their coasts, there is much port and harbor work which requires a greater use of concrete in sea water than is common with us. For this reason, the failure of cement in sea water has been given more careful study than with us. As early as 1853, on account of the numerous reports of the deterioration of marine structures, the French Society for the Encouragement of National Industry offered a reward for the best study on the cause of failure of cement in marine work, and for the past seventy-five years European engineers, chemists, and cement manufacturers have been seeking to find a cement that would be indecomposable in sea water, and it was the continued search for such a cement that led ultimately to the development of the aluminate cement industry in France.

ORIGIN OF ALUMINATE CEMENT

It may be well at this point to touch upon the genesis of aluminate cements. The story of their discovery is that of two investigators, widely separated by distance, each ignorant of the other's work, and each starting with a slightly different aim in view, reaching in the end the same conclusion and results.

I refer to the work of Monsieur Jules Bied and myself.¹ Mr. Bied, the Chemical Director of the La Farge Co., to whom the development of the aluminate cement industry in France is due, started his research with the specific object of finding a low lime hydraulic cement that would be resistant to the attack of sea water. Whether it was higher testing than portland cement or not was immaterial, as was the question of rapid hardening. The *sine qua non* was that it must be resistant to the attack of sea waters. On the other hand, my object was to develop a cement that would be quicker hardening, stronger, and more durable under ordinary conditions than portland cement, without specific regard to its behavior in sea water. In aluminate cement we both found our desire realized, but it was the resistance of aluminate cement to sea water, not its high strength at early periods, that led to the development of the aluminate cement industry in France, and I do not think the especial value these early strengths gave it for use in general construction was realized at first in France. At all events, I can find no record of the use of aluminate cements solely because of its higher early strength, prior to the use for artillery foundations, etc., during the war. Prior to that, aluminate cements seemed to have been used only where subject to chemical attack.

To return to our subject, the deterioration of portland cement in sea water is due to two causes, one physical, the other chemical. The physical decomposition is caused by the crystallization in the pores of the concrete of the salts dissolved in the water. This crystallization is produced when the concrete is exposed to alternate wetting and drying. It is mechanically similar to the effect of freezing, and can be guarded against by using dense, impermeable mortars. Chemical decomposition is caused by the sulfur attacking the lime or high lime compounds in the hydrated cement, forming basic sulfo aluminates. The very bulky crystals of this salt, which develop in the pores and interstices of the concrete, act as innumerable wedges forcing it apart. If the current of the sea water percolating through the concrete is sufficiently rapid, the sulfo aluminates may be washed out, and the action continued until the cement gangue be completely decomposed to a sandy mass. Both the physical and chemical action is accentuated by wave action, and in many cases of failure both causes of decomposition are present, each accentuating and intensifying the action of the other.

Immediately upon Bied's announcement of aluminate cement and its production in sufficient quantity, it was subjected to the most rigid tests in both governmental and private laboratories in Europe, and under conditions of actual work. These tests proved, as would be expected from its chemical composition, its resistance to the attack of sea water. The test of the Paris-Lyon-Mediterranean Railroad Company, begun in 1916, made necessary by the destruction by sulfated waters of the Brauss tunnel, show that aluminate cements resist perfectly the attack of water impregnated with sulfate of lime, even when a large part of the sand is replaced by anhydrite. As a result of these tests, aluminate cement was used in the reconstruction of the tunnel, and is now specified by the railroad company for all concrete work exposed to sulfate-carrying waters.

Dr. Jeaneret made very severe comparative tests between portland and aluminate cement, specimens were made one part cement, two parts sand, and one

part gypsum. These were rammed into molds and then immersed in water. The test specimens made of portland cement began to disintegrate shortly after two months' time. After three months the rapidity of disintegration was increased. At the end of four months the aluminate cements showed absolutely no trace of destruction, and gave compression strengths almost three times greater than was obtained from the two portland cements tested.

Candelot writes: "Whatever the explanation, the long experience we have now had with aluminate cement has shown that its resistance to sea water action is perfect, not only in the laboratories but in extensive practical use. * * * The aluminate cement therefore resolves all question as to concrete construction, either in sea water or in alkaline soils."

Other advantages, not so immediately obvious as high strength at early periods and resistance to the attack of sea water, are claimed for aluminate cement. It is stated that the concretes made from aluminate cement are more elastic and have higher tensile strength than those made from portland. These characteristics combined with the high resistance to compressive stress, make possible a marked reduction both in the area of reinforced concrete members and in the amount of reinforcing still required. Now, on one piece of work, a tobacco manufactory and plant involving the use of about 150 yds. of reinforced concrete, a saving was made through reduction in area of 14% of the amount of aggregate and cement required, and of 7% in the amount of reinforcing steel. The design and calculation for the reinforced concrete work on this job were made by Mr. Guillaume, the consulting engineer of the Societe Central de Travaux Public. Such a reduction in area more than compensates for the extra cost of the cement, and leaves the indirect gain, such as saving in time, amount of form lumber, etc., clear profit.

The second of these advantages is that the hardening of aluminate cement concrete is not materially affected by low temperature.

The third is that, with any given fine aggregate, aluminate cement used in the same proportions will give a denser, more permeable and less absorbent mortar than portland cement. This is an important factor in connection with resistance to the physical attack of sea water on concrete structures.

Aluminate cement mortars are more plastic than portland cement, and do not shrink in setting. These characteristics, combined with quick hardening and impermeability, make aluminate cement particularly adapted for outside plaster.

In my talk today I have purposely confined myself to a bare recital of information that has come to me from France. I have also limited the discussion to fields in which aluminate cement is directly competitive with portland, and have cited in support of each major claim, actual work, giving the names of the place where used and of the user. I could multiply these citations indefinitely, but believe I have said enough to convince you that using aluminate cement it is possible to build concrete marine structures with the positive assurance that they will be immune from the insidious chemical attack of salt water, and that you can put plain or reinforced concrete structures into service and subject them to the full load for which they are designed in from 48 to 72 hours after pouring.

I make this prophecy—as portland cement has been the magic and the great romance of concrete during the past twenty years, so aluminate cement will be the fairy wand whose use will make a reality of your dream of lighter, more elastic, more beautiful and more enduring concrete structures for the future.

¹It is with great sorrow that I learned since the writing of this paper of Mr. Bied's recent death, as during my two years' service in France, as Commanding Officer of Cement Section A. E. F., we saw much of each other and became strong personal friends, and have since cooperated and exchanged information concerning aluminate cement.

Architectural Concrete

BY JOHN J. EARLEY

ARCHITECTURAL SCULPTOR, WASHINGTON, D. C.

Presented as part of Symposium on Progress of Concrete Construction in 20 years at 20th Annual Convention, Chicago, February 27, 1924.—By courtesy in advance of copyrighted *Proceedings*, Vol. 20, American Concrete Institute.

Architectural concrete is a concrete which meets the requirements of the architect and which is approved and used by him as a building material. The architect has absolute authority, and is the sole arbiter of the building industry. Only those things which receive his approval find a permanent place in it. To force a way past him is useless. There is nothing to be gained but the shell of ostracism or the bitter cup of disappointment. It is just and right that such absolute authority should rest in the architect, because only in him is the full knowledge of the industry. To him belongs the treasure which experience has lain up through the ages.

It is hard for some to understand why the architect should have power to reject any material because of a poor appearance, and they wonder how he describes as poor an appearance which is thoroughly satisfying to another. But one man's judgment is not as good as another's. The architect's opinion is founded on the common experiences of many men through many generations. The knowledge which he possesses may not be in scientific form, but it is true knowledge nevertheless. Scientifically expressed knowledge may aid in speculative thought and in the rapid development of technique for new materials, but it is not absolutely necessary for either.

Knowledge, like truth, is simple. It is complicated only in its expression. The knowledge possessed by a fine craftsman differs in no way from that of a great scientist excepting in form. When Michael Angelo built the dome of St. Peter's Church in Rome, he knew the stresses in that structure and took care of them efficiently and well. But I doubt whether he could have made the calculations in such form as to meet with the approval of modern engineers. When the vaulted roofs of medieval cathedrals were propped by flying buttresses, the designers with intuitive knowledge, with the knowledge of a craftsman, correctly translated the stresses. I am sure they could not have calculated them, nor have expressed them on a diagram, and I wonder how many engineers there are today who can do so. During the world war, a striking example of what I mean was brought to our attention: The United States decided to build a number of concrete ships, and inquiry was made of the world's best authorities on ship-building for scientific knowledge of the stresses set up in ships in high seas, and none was found. Do you think that the race of men through all its history has gone down to the sea in ships built by those who knew nothing of them? Such a question is ridiculous. They did know! The shipbuilder and the marine architect had a craftsman's knowledge. The experience of ages had left to them real and practical knowledge. The recent work of certain scientists has clearly shown the normal eye to be a correct instrument which gives the sensations proper to the stimuli received. Therefore, we may conclude that the architect, when he rejects a material because

it has a poor appearance, is neither blind nor mad, but is exercising a prerogative which is justly his, and which he is qualified to use.

Within the past twenty years, concrete came to the architect and asked for a place in the building industry. It said, "I am young and strong, will work faithfully and for low wages." The architect replied, "All this I know, but your appearance is below my standards; therefore, I will not employ you." Concrete decided to work in the building industry in spite of him, but somehow things did not go well, and concrete came to recognize the authority of the architect and the need for a better appearance. Only a long story could tell of the efforts which have been made and the devices which have been employed to improve its appearance. These efforts have been made along traditional, and I must admit, logical lines. The first movement is always to present a new material in the guise of an old. I do not mean you to understand that this is not proper. It is.

When electricity came into general use for illumination, the mechanics of its installation was in no way standardized, and the nature of its light was little understood. The fixtures which had been employed for gas and candle lighting, and which through many years had been developed into artistically acceptable forms, were of necessity used. Only recently, after the mechanics of installation has been standardized and the nature of the light has been better understood, have electric light fixtures assumed distinctive form.

The first development of an artistically acceptable appearance for concrete was the work of those who presented concrete in the form of stone. They are to be praised and encouraged. They made the necessary preliminary effort, and will hold what has been gained while a true technique is being developed. Within the past few years, concrete stone has been made into a fine product, and has been able to meet artistic requirements in a manner equal to the natural stone which it simulates. In this form it has served a useful purpose, and will enjoy popular favor until an appearance peculiar to concrete has been developed and put into general use. In all probability the time required for this will be sufficiently long to insure a just recompense to those who have been pioneers. We cannot, however, accept concrete stone as the full measure of concrete's ability to assume a good appearance, any more than we can accept an electric candelabra as the ideal electric light fixture.

When you realize that considerable knowledge of the material and reasonably uniform methods for handling it must precede any useful work on its surface treatment or appearance, and when you recall how short a period of time has elapsed since concrete has been treated as a plastic of great mobility and not a granular solid to be pushed and tamped into place, you will understand what I mean by saying that the development of a good appearance for concrete has been rapid. Within recent years, certainly within the past five, there has been an earnest effort to apply all available information to the problem. It has attracted men who can bring to it not only the trained sense of

the artist and the architect, but also the knowledge of the craftsman and scientist. Through the cooperation of the members of this Institute, we have learned much of the nature of the materials in concrete and of their control.

The elements of a good appearance are three, namely, good form, color, and texture. And the experience of the past few years has taught that concrete of any form, color and texture can be made by the proper selection of the materials, particularly of the aggregates, and by the effective control of them while in a plastic state. With regard only to its appearance, let me suggest that concrete be thought of as an aggregate, which is held in place by the least possible amount of hardened cement paste, and which before the hardening of the cement was flowed into place in a vehicle of water. This gives the idea that it is the aggregate which takes the form and gives the color and texture, that the cement is a binary material and has no part in the appearance, and that the water is a carrier which places the material with the least amount of work. This idea is the most valuable fruit from the past twenty years of work on concrete surface treatments, and it is our stake for the adventures of the future.

Although concrete is a plastic material which hardens in a mold, and although the forming of concrete is a casting process, nevertheless concrete has certain peculiarities which prevent the technique developed for other plastic materials from being applied to it. When the dry materials of concrete are mixed with water, they will in time set or harden, but they do so in a different way from other casting materials. Plaster of Paris, for instance, when mixed with water and cast in a mold, will not segregate nor lose volume, but, on the contrary, will increase a little in volume, and by this insure complete filling of the mold and a sharp cast. In addition, it will set quickly. Concrete does not act in this way. When placed in a form or when cast in a mold, there is no increase of volume, there is no stability of mass. The solids tend to separate from the water, to settle towards the bottom of the mold, also to fall away from the vertical surfaces and the underside of the horizontal ones. Water immediately fills the place left by the moving aggregates, and the result is a dull, unattractive casting. Castings made of concrete usually contain a greater volume and weight of material than comparable castings in any other material, and require a longer time to set or to fix the volume of the material against changes. All of these things, when not controlled by a proper technique, naturally cause the form of concrete to fall short of architectural requirements. These shortcomings have unfortunately been very general, so general, indeed, that architects have come to accept them as necessary and have allowed modifications of form, have omitted architectural moldings and reliefs because fitting execution could not be expected in concrete. Contractors have encouraged them in this belief, and have by this means avoided technical difficulties. Some of the experiences of my studio would be humorous if they were not sad. Architects submit their problems of concrete surface treatment with apologies, with fear that their drawings are too elaborate even though simplified to the point of crudeness, and with hope that we will do our best to retain what little is left of the esthetic.

The color and texture of concrete are in a similar state of disorder and from a similar cause, namely, misapplied technique. While color and texture are only adjuncts of form, nevertheless they are to the artistic sense necessary adjuncts, just as the sensation of color, although not necessary to vision, is the

fullness of sight. Of all the materials and methods of coloring, paint is the commonest, and the technique of painting is probably the best known of the decorative crafts. This probably accounts for the efforts many have made to apply it to concrete. With pigments, coloring is usually done by adding to a base, such as white, material of another hue. The base is thus changed in hue and chroma, according to the kind and amount of material added. Experience has taught that a base should be neutral, that is, it may range in value between white and black, but it may not have an appreciable chroma of any hue, particularly of a hue opposed to the colorant.

The coloring of cement by methods similar to those employed for pigments has not been successful, because cement, even white cement, is not a neutral base. It has color sufficient to interfere with that of an added pigment. The difficulty is aggravated by the chemical activity of the cement, which attacks the structure of many of our most desirable pigments. Furthermore, the addition of finely ground pigment weakens the cement, therefore the addition of an amount of pigment exceeding a small per cent of the volume of cement is not permitted, and as a result, concrete cannot be given a hue of great strength, a hue approaching in strength that required for adequate decoration.

I do not mean to be discouraging by the difficulties which I have pointed out. They are of the past rather than of the future, and I have reviewed them for the sole purpose of impressing you with the desirability of a technique proper to concrete. The fundamentals of such a technique have been developed within the past few years. Much must be added before the control of concrete will constitute a craft, but I think in time this will come about. As stated before, the chief fruit of our labors is the recognition of the aggregate as the major factor in the appearance of concrete. It is by constructing a skeleton of aggregate that volume changes, settlements and segregation are prevented, and the necessary perfections of form are secured. It is by causing the aggregate to occupy a very great part of the surface that predetermined color and texture are obtained. Coloring is not so difficult by means of aggregate as by means of pigment. Aggregates are not impaired by the action of cement, the strength of chroma is not limited, and the character of the concrete will be permanent. A great wealth of color knowledge, all that of the impressionist or pointilist school, can be immediately applied to concrete if we consider each grain of aggregate as a spot of color placed in just position to other spots, all of which will blend in the air to a hue of even value and chroma. As a result of the experiences of the past twenty years, I do not think the American Concrete Institute would be hasty if it announced that the problem of giving a proper appearance to concrete has been solved, and that subject to further development, the technique of concrete surface treatment has been indicated.

Within the next ten years, I expect to see concrete a fully accredited artistic and architectural medium. Because of my peculiar position as an architectural sculptor, I am able to understand the position of the architect and to respect his arbitrary stand; I also have a craftsman's knowledge, and am able to see the possibilities of concrete in art and architecture, its great facility, its exquisite form and color, and its limitless textures. This forecast for the future is not, therefore, an enthusiastic hope, but a reasonable expectation.

A new building material, one of major importance, after it has gone through its novitiate and has been accepted, usually begins to exert an influence to give its own character to the work in which it is used.

That concrete will be no different in this respect from other materials is proved by those artists and architects who are using surface treated concrete to a considerable extent. Certainly we may expect concrete buildings both in their structure and appearance to develop an individuality equally as marked from that of standard masonry as the latter is from frame.

I think there is as great a desire on the part of the architects that concrete be speedily given a good appearance as there is on the part of the cement and concrete industries. Every architect realizes that the cost of building is out of balance with economics, and that for expediency many of the proprieties of his art must be sacrificed. He knows that these sacrifices have been made to an extent which threatens decadence.

Construction Superintendent's Question Box

A number of questions propounded by construction superintendents of the American Concrete Institute prior to the convention, were discussed at a meeting especially for superintendents. (Monday evening, Feb. 25.) The questions were not assigned for discussion to the members with whom they originated, and all present at the meeting were invited to take part in the general discussion.

Cold Weather Methods

Discuss protective methods in mixing and placing concrete in freezing weather with a view to obtaining the best results possible.

What is the effect of freezing temperature upon plain or reinforced concrete slabs? What is the effect upon plain walls and reinforced columns and beams (assuming that 3/8-in. form work is used)? To what extent does heating with fires under forms affect the result? What is a safe table to use giving the time necessary to leave supports below beams and slabs under the above weather conditions?

My chief concern now is concreting in cold weather—how many salamanders per cubic ft. of building and canvas-enclosed walls. Do all or any of the anti-freezing compounds work satisfactorily under general building conditions, and what is the lowest temperature at which concrete can be placed successfully? I appreciate that if one has an unlimited expense account to have everything ideal, concrete can be placed at a very low temperature; but every contractor's aim is to put it in at the least expense, and ordinary buildings, unless the owner will stand the extra expense, do not permit this additional cost.

How do you keep canvas curtains on a building when the wind blows from 40 to 60 miles per hour? Would really like to know, as I have had 30 curtains blown to shreds this past week.

J. C. Grady described a method used in placing a reinforced concrete roof slab on a structural steel building in cold weather, whereby the slabs were precast and put in place at the same cost as casting in place in warmer weather. Reinforced slabs 2 ft. x 8 ft. by 3 in. thick were placed so that the joints which came over the I-beam supports could be filled with mortar. Calcium chloride was used in the mortar to accelerate its hardening.

M. M. Upson cited a job completed over 20 years ago in which salt was used in the mixing water for concrete placed at temperatures below zero. Concrete walls in the building ranged from 8 in. to 14 in. in thickness. All materials going into the concrete were heated so that when placed in the wall forms, the concrete had a temperature of about 85°.

Prof. Duff A. Abrams cited that small percentages of salt as 1% or 2%, accelerate the hardening of concrete whereas 6, 8 or 10% decreases the strength. As an example, it was stated that sea water containing 3 1/2% of salt gave normal results particularly in the case of the Florida East Coast R. R. where the results have been very satisfactory. The further opinion was expressed that calcium chloride was more satisfactory than common salt as the common salt depresses the freezing point of water only a little, while calcium chloride accelerates the setting properties of the cement as well.

E. D. Boyer pointed out that calcium chloride has different effects on different cements.

William F. Tubesing emphasized the importance of using adequate methods for heating the aggregates and for protecting the concrete from freezing after it was placed, by the use of salamanders.

Such periods of artistic suppression have occurred before and have been relieved only by an economic change, by something which made it again permissible to properly decorate. Armies returning from the Crusades brought memories of graceful minarets and beautiful domes, they also brought hands a plenty, and the influence of both is easily seen on the architecture of Europe. When we think of the saving in the labor required to form and place a plastic mass over that required to form and place a solid mass, and of the wonderful possibilities which better knowledge will give to concrete, may we not conclude that this is the economic change which will allow a fuller and greater development of structural and decorative forms than did the return of those men from the Crusades.

J. A. Turner described a very satisfactory method for keeping concrete above the freezing temperature in building construction by canvassing in the building, making all enclosures tight including the top and leaving heat holes in the slabs through which the warm air could pass.

The number of salamanders, it was cited, varied with the location and climate, sufficient salamanders being required to produce a temperature of from 60° to 70°. The heat holes in the slabs were recommended to insure setting of the concrete at the top as well as the bottom. A space of 3 or 4 feet should be provided for between the salamanders and anything burnable. Coke fires were recommended in preference to wood fires.

The discussion further emphasized the necessity of allowing the concrete to harden rather than to dry out too rapidly as a result of the heating process. One salamander for each bay was recommended as a minimum. The use of thermometers at the top and bottom of columns was advised because of the tendency of the concrete in the columns to freeze at the bottom first.

The use of live steam instead of salamanders in buildings in Pittsburgh was described. Other methods which had been tried out included flooding the top floor with water and heating the under side of the slab with salamanders below. In the case cited, the water froze about 1 in. on top of the slab without any bad effects to the concrete.

Other interesting points brought out were: That heating the concrete is more important than protection after placing and that the extreme heat under the salamanders affects the floor unless 2 or 3 in. of sand is placed with a diameter of about 5 ft. under each salamander. A possibility of receiving heated material from the supply houses, free from frost was suggested as an important aid in cold weather concreting.

Accelerators

I have many times been provoked at cement concrete setting slowly in cold weather; a cement finisher will have to wait several hours for the cement to set sufficiently to work it and of course charge for the time waiting; with the present high wages, it makes quite a difference between winter work and that of summer. Is there anything a person can use to hurry the setting, without injuring the strength of the finished product, outside of heating materials to be used? The firm I am with is rather suspicious of all kinds of dope advertised for this purpose.

What are the advantages or disadvantages of using calcium chloride to accelerate the hardening of concrete? If calcium chloride is used in floor finish, does it have any effect on the use of floor hardeners at a later date? Does calcium chloride, when used in concrete, have any effect on steel reinforcement or structural steel coming in contact with the concrete? Has any trouble been experienced by cement finishers when an accelerator has been used in floor finish?

The discussion of questions under "Accelerators" was largely grouped with that of questions regarding cold weather methods. The necessity for care in placing the finishing course on a concrete floor was emphasized, it having been found necessary to protect the floor finish from the injurious effect of gases from the salamanders. It has also been found necessary to exercise extreme care in finishing monolithic floors with metallic hardeners in very severe weather. Instances were cited where it seemed impossible to keep the finish from freezing before it was actually floated smooth and although the floors were prepared under unusual conditions, the resulting finish was comparatively satisfactory.

Concreting Inclined Slab

What is the best way to concrete an inclined slab so as to secure the best results, both in regard to strength and looks, at the same time with facility in handling the concrete?

Various methods for concreting inclined slabs were suggested. The use of burlap on the bottom of the form for inclined roof slabs was recommended by Kate Gleason. This method proved successful in preventing the concrete from running as the burlap absorbed some of the water and kept the concrete in place.

A method for getting around the question of concreting on inclined bottoms for ore pockets was described by Prof. Duff A. Abrams as that of building the slabs separately and placing them after the concrete had hardened, where the slope was too great to keep the wet concrete in place. Other methods suggested included using forms on both sides of the slab, building up the top forms, one board at a time. Also the use of removable forms or removable panels. Openings were left about 3 ft. apart on the top form and the concrete which had about a 2½-in. slump was jarred into place with the aid of air hammers to vibrate the bottom form of the inclined slab.

Machine to Make Separators

Would there be a demand for a machine, the cost of which would be very low, for turning out in quantity concrete separators and doughnuts for use in wall and column forms?

A small and rather crude machine was described by J. G. Ahlers which was made about 5 years ago and is still giving service. The original cost was about \$50, the spacers being turned out with the aid of brass molds and brass pins going through them. The doughnuts were made by hand in tin molds and set to cure. It was not found practical to go into the business of making these machines as they would be cheap and there would not be enough market for them. The concrete spacers are used to keep the column bars the correct distance away from the exterior of the columns, but in beams and slabs, commercial separators are in general use.

The use of "U" separators instead of doughnuts was suggested as more practical for use in columns and also in beams, as they serve to keep the bars and stirrups away from the beam side.

4-Cylinder Gas Engines

Is the new 4-cylinder type of gas engine more dependable than, and superior to, the old one cylinder?

The 1-cylinder engine was reported as the most successful in certain machines up to 5 h.p., it being universally the most simple and easiest to operate. One- and 2-cylinder engines were recommended for certain machines, such as half-yard mixers and three-quarter-yard mixers. For 15 h.p. and over, the 4-cylinder engine was recommended. This equipment displaces the old electric motor and steam engine. Four-cylinder engines of from 25 to 40 h.p. are being used on steam shovels and big locomotive cranes because of their simplicity and their economy of operation. Their use does away with licensed engineers and firemen and prevents excessive overhead charges on days when the equipment is not in operation. The single cylinder gasoline engine was recommended in mixers up to 1-bag as being more economical and more easily handled than the multiple cylinder engine.

M. M. Upson cited that steam engines for operating locomotive cranes and shovels have been practically replaced by 4-cylinder gas engines along the Pacific Coast, particularly in Southern California where gasoline is available at a low cost.

Reinforcing Details

Is it not reasonable to ask and to expect that element of the architectural profession and some of the engineering profession who now furnish comparatively meager details of reinforcement, to show, in fully detailed and properly referenced drawings tying in details to floor plans, the arrangement of rods at points of intersection of beams and girders; also, notes with reference to steel in structural members, such as "1½ in. square rod—50% bent up at quarter points"? Responsibility shirked by the architect is thrown upon the contractor, who passes it along to the job superintendent, where it reposes as a misplaced burden. The extent of this weakness on the part of architects may be judged by the action of the bar companies and their agents of setting up organizations to furnish purchasers with workable reinforcing details.

The opinion was expressed by M. M. Upson that the contractor, in order to be successful, generally has to be able to supply the details of concrete reinforcement.

It was pointed out that a majority of the better architects are employing structural engineers to design their reinforced concrete. They make complete drawings giving sufficient information to the contractor so that he can make his complete bar list. The architect or engineer welcomes constructive criticism and in general the contractor should be given sufficient information so that it really is unnecessary to ask questions about the details. The opinion was expressed that the contractor hardly has the right to expect a complete drawing of every beam and of every bar in the beam. But on the other hand, the architect has the right to expect the contractor

who undertakes a reinforced concrete job to understand how to place steel and how to assemble his reinforcing.

Further opinion was expressed that the engineer should be expected to show all the details for two reasons. In the first place, this will assure him obtaining the kind of a job that he wants, and in the second place, he ultimately pays just as much for work as if he were to detail it in the first place. It was cited that in Milwaukee, the detailing of reinforcing is left to the reinforcing bar companies for which a charge is made of about \$1.50 a ton. These detailed drawings furnished by the bar companies are finally checked by the engineers.

Quality on the Job

I have taken my question from your letter head "We will learn to make better concrete." The average construction man would like to have the American Concrete Institute determine the best method to enlighten the concrete foreman, who has in most cases not had the advantages of even a high school education, as to the use of water in concrete and also the grading of the aggregate. I have had occasion during the past year to take a number of our foremen to hear some of the lectures on the grading of aggregate and water content, and I am sorry to say that practically all of these lectures were so technical that they were far over the head of even the more enlightened listener. I think that a real effort should be made to conduct a series of lectures in the different parts of the country, explaining in simple language that the slump test is simply a means by which one can determine the amount of water that can be used, and also to inform them in simple language of the method of grading the aggregate to take the place of the 1:2:4 measured by volume which they have used in the past. I believe that an expression of opinions as to the best method to obtain these results would be well worth while.

The control of the quality of concrete is our greatest problem. Apparently your Committee C-6 intends to cover this subject. However valuable their report may be from an engineering point of view, it isn't going to help the job if it is language that only an engineer can understand and appreciate. If you want better concrete on the job, get your reports out so a concrete labor foreman can understand and follow their recommendations. When the reports for this meeting are in, ask yourself the question if this is possible.

How much of a load can be safely placed on 1:2:4 concrete three days old?

These questions refer entirely to field methods of improving the quality, particularly connected with the personnel of the organization. The questions propounded on this subject were resolved by Stanton Walker into the following: What can we say in simple language to the man in the field to make him understand how and why to control the proportions of the materials to obtain concrete of uniformly satisfactory quality at the greatest economy. It was stated that practically everything that has been said or written about concrete in the past several years is along the lines suggested by F. R. McMillan at the 1923 convention which was, in effect, to use as little water as possible, as much stone as possible and after the concrete is placed, to keep it as wet as possible. An important conclusion drawn by Mr. Walker was to the effect that the betterment of the quality of concrete in the field lies not only in the education of the field man but in the betterment of the methods of measuring materials. The design of concrete is on a par with the design of a reinforced concrete structure. The carrying out of instructions is simple if the proper means for measuring the proportion of materials is provided. One method proposed for measuring the materials was to have hoppers with straight sides with mechanical strike-offs. One job on which this type of equipment was used gave very satisfactory results as the judgment of the mixer operator was not depended upon in any way. On another job the method proposed by R. L. Bertin, which involved measuring the sand in an inundated condition gave very satisfactory results.

The question as to how much of a load can safely be placed on a 1:2:4 concrete 3 days old was referred to by Stanton Walker as one that does not permit of a single answer applicable to all conditions. The shape of the member has a very important bearing. A study of the results of tests made at the Structural Materials Research Laboratory brings out the fact that the relation of the strength of the concrete at one age to that at another is directly proportional to the concrete at some one particular age, selected for comparison. A standard test specimen, cured in damp sand at ordinary temperatures, would have a strength at 3 days of from 20% to 25% of the strength at 28 days. As the relation is fairly definite for concretes of various strengths cured in this same manner, a 1:2:4 concrete of the consistency ordinarily used in building construction having a strength of about 2000 lb. per sq. in. at 28 days could be expected to have about 500 or 600 lb. per sq. in. at 3 days. The temperature at which the concrete is cured affects the strength more at the early ages than later.

The best results in obtaining increased early strength of concrete with the use of accelerators was stated to be obtained with the use of 2% to 4% of calcium chloride. The high alumina cements in use in France which give high early strength were referred to. A method used in Italy for making concrete for roads was described as one in which a patented process involves the use of 1 part of cement to about 1¾ parts of crushed granite about ½ in. to 1½ in. in size. There is no fine material and the concrete is mixed very dry and rammed into place.

N. M. Loney suggested that it is hopeless to expect the men in the field to get much of the theory in properly designing concrete mixtures. The results obtained with weighing machines indicate that it is entirely feasible and practical to measure all quantities on the job where concreting operations are sufficient to warrant the expense of installing the apparatus. The weighing machines are fixed with an automatic arrangement for choking off the supply when the desired weight is obtained.

The fact was cited that, on paper, it is very easy to demonstrate that weighing aggregate ought to give considerably more accurate results than any volumetric measurement. The volumetric measurements were referred to as incorrect by reason of the bulking effect particularly in the case of sand whereas weighing will practically eliminate these errors. M. M. Upson referred to the importance of a more accurate proportioning of the aggregates in concrete. This was cited as a field in which there is a wide opening to the ingenious manufacturer of concrete equipment.

It was stated that where a job is large enough to require an overhead bin for sand and stone, the bin can be raised a little and an automatic scale used very readily for the purpose of weighing the aggregates for the concrete. The scale is connected with the supply above, the supply being cut off when the scale has received the proper charge which can be varied to suit the requirements.

N. M. Loney followed the remarks as to the strength of concrete in 3 days giving the opinion that no one ought to receive the notion that you can put a load on a concrete structure at 3 days with the forms removed. The answer to that particular question should be no load whatsoever at 3 days.

Accident Prevention

What is the quickest and most forceful way of bringing home to every worker the necessity for care in preventing injury to himself, to others, and to the company's equipment?

In the matter of accident prevention, according to E. C. Harding, this question will be answered by first selling the contractor the idea of safety and accident prevention. He in turn sells it to his superintendent and the superintendent passes the idea on to the men. This was believed more satisfactory than dealing directly with the men without the idea coming from the contractor himself. The use of posters, selected from those sent out by the National Safety Council, picking out such pictures as pertained to building operations was suggested as a very simple but effective accident preventive measure. Where an honor flag is to be awarded for the least number of accidents or for no accidents, it has been found that many of the accidents are not reported.

Floor Finish

Assuming that only good ingredients be used for finish, what procedure in the placing of 1-in. finished floors afterward on the rough concrete slab will insure finished floors which will not crack and loosen from the rough slab? To what extent does the proportion of the mix for finish affect the loosening up of the finish from the rough slab due to difference in coefficients of expansion in the rough concrete slab and in the finish slab?

Has anyone ever laid a concrete floor satisfactorily without pouring it monolithically?

* * *

Assuming that only good ingredients be used in mixing finish, is it possible so to formulate the method and practice in placing monolithic finished floors that the construction superintendent can in all cases be absolutely sure that the result will be a first class durable floor? The solution of this problem should take into account the following varying conditions:

- a. Varying weather conditions.
- b. The need of putting in large areas of finished floor in a single day.
- c. The factor of speed in construction which makes it necessary that workmen get on the finished floor within two days after finish is placed to erect forms for the next story.
- d. Placing finish in winter when it is necessary that heat be applied to the slab both bottom and top. How can dusting of the floor or a soft finished surface due to the action of the heat and the gases from open fires be avoided?

* * *

Is there a cheap dust that can be put on top of finished slabs so that the droppings from the slabs or pour above will not adhere to finished slabs underneath, as I have found sawdust, mill shavings or sand do not properly take care of these droppings?

* * *

Why do not engineers and architects more generally advocate the placing of a 1-in. floor finish at a later date, rather than monolithic with the structural concrete?

In discussing the question of floor finish, L. J. Fairchild stated that the Eastman Kodak Co. has about half a million square feet of floor space, most of the surface of which has been laid after the structural slab had hardened. Specifications state that a floor finish laid on the ground slab may be laid monolithically but all other floors are to have separate finish.

The structural slab is roughened at the time or picked afterwards, before the application of a 1-in. finish. This is proportioned about 1:3. The best results were obtained with patent floor finish, mostly according to the Kalman patent.

J. A. Turner stated that most of the work with which he had been connected in the past had been done with a monolithic finish rather than with the finish laid afterwards, particularly because a monolithic method insured a perfect bond and there was no danger of the surface coming loose. It has been found later that a 1-in. finish can be put on and properly bonded giving equally good results without the marked effect from the scratches and scars that the floor gets when it is green. The further advantage was mentioned that the floor can be finished after the building is closed in where the separate finish is applied.

No provision is made for expansion in floors except where the finish is put down afterward when an attempt is made to place the joints over the construction joint below.

Time of Mixing

I would like to know what strength is added to concrete by mixing the batch 1½ to 2 minutes, as against one minute mixing, using a concrete mixer 16 to 20 r.p.m.

Prof. Duff A. Abrams cited a series of tests carried out a few years ago at the Lewis Institute which proved that the strength of concrete is a logarithmic function of the time of mixing.

Other conditions being equal, mixing for 1½ min. indicated an increase in strength of 130 lb. per sq. in. over a 1-min. mixing, or an increase of about 6%. Mixing for 2 min. gave an increase of 10% over the strength of concrete mixed for 1 min. The general conclusion was drawn that for the usual mixtures and consistencies, doubling the time of mixing increases the compressive strength of concrete about 10% regardless of the mixing time considered. This effect of time of mixing was not uniform over a wide range of proportions. It was more effective for the lean mixtures than for the richer, more effective for the dry mixes than for the wet and more effective for the small sizes of aggregate than for the usual concrete size. These tests were turned out for mixing times ranging from 16 seconds to 10 minutes. A less time than 15 seconds was not found practicable.

Referring again to the subject of floor finish, Mr. Grady mentioned floors that have been in place a good many years and have worn down in the trucking aisles to such an extent that there is danger from loss of compression of the slab. Instances were cited where the 1-in. floor finish was put on from 3 to 6 months after the first floors were laid and that after much hard usage such as the moving of pianos on hand rollers over the floors and handling machinery, the floors are in good condition.

An acid wash was recommended as a first treatment for the floor to be surfaced. After the acid wash the floor is washed with clear water and swept before the finish is put on.

Some definite rules, for bonding 1-in. floor finish to the slab below were given by S. C. Hollister. The specifications include the following: Make the slab on which the surface is to be applied rough, and clean it of all dirt or dust or any loose particles, down to the concrete surface. Remove all laitance. After the floor is properly cleaned, and the surface roughened, all the water that the floor will absorb should be applied, by sprinkling at intervals, until it is saturated. This treatment will take from 24 to 36 hours. Then apply the topping, preferably without putting any dry cement on the surface first, the topping to be a 1:2 mix, one of cement and two of aggregate. The topping should be troweled on carefully and the surface given whatever finish is desired. No excess water should be standing on the slab when the topping is applied.

In regard to the use of soft coal cinders in slabs, it was pointed out that the instances where the reinforcement in the slabs was entirely gone and where heating lines and plumbing lines had big holes eaten in them, in the cinder concrete, the trouble lies entirely with the sulfur contents where soft coal cinders are used. The question of the use of cinders hinges on the amount of impurities they carry with them.

Forms

It would seem to the writer that we will eventually have either to standardize our designs to a greater extent than has been done in the past to permit the re-use of forms, or work out some method which would involve the use of more metal instead of lumber. This question, I believe, is far more important than plant layout and I think it is worth serious consideration by all those interested in reinforced concrete work.

* * *

Can and should the present type of wood forms be improved so as to eliminate the necessity of pointing up after the forms have been removed?

L. H. Uilson referred to the question of forms from the standpoint of cost as the most important on the ordinary concrete job. The forms should be so designed and the work so planned from the beginning of the job that form sections can be easily altered for re-use, as the actual cost of building the forms is influenced by the saving in the amount of lumber used and often in the saving in time on the job. A lost day on some particular job often means a week, especially where the floor is not finished on Saturday or on the previous day. This leads to unbalancing of the job and more floor men have to be put on in case of special form work.

The item of pointing referred to in the second question about form work cannot be entirely eliminated by improvement in forms. A certain amount of pointing is due to improper grading of the concrete and for ordinary jobs, a good finish can be obtained with ordinary form work and care. If an exceptional finish is desired, it is more economical to plaster the surface than to go into more refinement in the forms.

The use of matched lumber for forms was questioned except in case of panels where the sheathing is not separated and the concrete does not get into the grooves. Beveled edges for the sheathing have been found more satisfactory as the swelling of the boards due to the moisture in the concrete forces the edges together making a tight joint. Where matched lumber is used for sheathing, the carpenters driving the sheathing together use an 8-lb. sledge instead of a hammer and make it a point to drive the joints tight between the boards.

The Economic Value of Admixtures

From a paper by J. C. Pearson and Frank A. Hitchcock, both of the U. S. Bureau of Standards, at the Convention of the American Concrete Institute, Chicago Feb. 25-28, 1924. Published by courtesy in advance of copyrighted *Proceedings*, Vol. 20, 1924.

In their introduction, the authors refer to admixtures as substances other than cement, aggregates and water which are added to concrete mixtures for the purpose of imparting to the latter certain improved qualities.

Admixtures of many different kinds have been marketed and used, but we are more accustomed to think of the term as applying to finely divided materials, of which hydrated lime is probably the most familiar example. Such admixtures are claimed to improve the plasticity or workability of concrete and mortars, and there is no doubt that this effect is pronounced in the case of mortars. Nevertheless it is a fact that this property is not readily susceptible of measurement, and so far as we are aware, no method has been devised for determining which of two mortars, nearly alike in plasticity or workability, is actually superior in this respect. (To avoid confusion we shall consider plasticity and workability to have the same meaning throughout this discussion.)

This question is of considerable economic importance, for if by any means a mortar or concrete mixture can be made more plastic and still serve its ultimate purpose satisfactorily, it means a saving in labor cost, and a more uniform product under given labor conditions. We believe that the importance of this question has been grossly under estimated, probably for the reason that there has been no answer to it.

About two years ago the authors seriously took up the problem of finding a method of comparing the workability of concrete mixtures. Previous to that time abortive and unsuccessful attempts to measure this quality had led to a single conclusion—that the difference in workability was there, and that neither the slump test nor the flow table furnished any information on this elusive property. We knew, as everyone knows, that a 1:2:4 mixture of a given slump or flow or "consistency" was easier to mix and place in forms than a 1:3:6 mixture of similar consistency, but what was it that one could put his finger on and measure, to demonstrate that the former was easier to handle and place in forms? We tried many methods—direct methods, such as measuring the amount of work necessary to move a concrete mixture from one place to another; but this failed because we could not tell when the transfer had been completed. We tried indirect methods, such as measuring the tendency of the concrete to retain its mixing water in a filter; we had fair success with methods of measuring segregation, but these failed when the concrete approached anywhere near the same degree of workability. After much study we came to the conclusion that the most obvious difference between concretes of different workability was the tendency of the harsher mixes to allow their solid constituents to settle and pack at the bottom of the mass. Then followed a search for a method of measuring this packing, and finally we devised a simple penetration test which was described last year before the American Society for Testing Materials.¹ This test is only a partial solution of the problem, but it is of interest because it has enabled us to demonstrate and compare the effects of admixtures on workability.

The authors summarize the most important results of this investigation as follows:

(1) The workability of any concrete mixture is about equally benefitted by one part of celite, two parts of kaolin, or three parts of hydrated lime, such as used in these tests, if the consistency as measured by the flow table is kept constant. Under the same conditions plain calcium chloride did not improve the workability, whereas of the two proprietary compounds used, one was found to give a very appreciable improvement and the other quite a marked improvement.

(2) The powdered admixtures in the proportions used did not seriously affect the strength of 1:2:4 or leaner concretes; in fact the 1:3:6 concretes were benefitted by the admixtures in all cases. Considerable reduction in strength resulted from the larger proportions of the admixtures in 1:1½:3 concrete. With reference to actual concreting operations these conclusions are conservative, for it was observed that as the workability of a mixture was improved, the tendency was to use less mixing water than was required to maintain the prescribed flow. In other words, the more plastic mixtures seemed overwet in comparison with the others, and more water was used in them than appeared to be necessary or would probably be used under job conditions to obtain a desired "consistency." The results of the tests reported herewith indicate that a judicious use of admixtures in

concretes which need improvement in respect to workability will not materially impair the strength. The chloride admixtures without exception produced a considerable increase in strength.

(3) The slight tendency toward reduction in strength of concretes containing the powdered admixtures was if anything more pronounced under dry or partially dry curing conditions than under damp storage conditions. On the other hand the chloride admixtures were relatively of more benefit under dry conditions.

(4) No appreciable effect on the shrinkage of the plastic concrete was noted from the use of admixtures.

(5) The increased yield of concrete containing powdered admixtures is in favor of the latter, and in many cases is probably sufficient to entirely offset the cost of the admixtures. The net saving from the use of admixtures is not in cost of materials, but rather in labor cost and greater assurance of uniformity in the finished product.

(6) The voids in concrete are affected only slightly by admixtures, apparently reflecting the effect of the admixtures on the gaging water. If admixtures necessitate the use of more water for a given consistency, the voids will be increased proportionately, other conditions being the same.

(7) Powdered admixtures do not seem to prevent loss of water from concrete by evaporation under dry or partially dry curing conditions, but chloride admixtures reduce the loss under these conditions. Corresponding effects upon the compressive strength were noted above.

(8) The authors believe that the data presented herewith justify a more general consideration of the proper use of admixtures. Better and more economical concrete must result from anything that improves the plasticity or workability of the mixture, provided no deleterious effect is also involved. It has been shown that small proportions of powdered admixtures do not detract appreciably from the strength of the concrete except in the rich mixtures, where the need for the values of such admixtures disappear. On the other hand the improvement in workability that can be brought about by the judicious use of admixtures is considerable, and this must tend to reduce costs and improve the uniformity of the finished product, under given labor conditions.

As a guide to "judicious use" of powdered admixtures, the tests indicate that the amount of an admixture to be recommended is an inverse function of the richness of the mixture. For the materials used in this investigation, the maximum percentage of celite is approximately the number of parts of coarse aggregate (relative to the cement) used in the mixture; the maximum percentage of kaolin is about twice the number of parts of the coarse aggregate, and the maximum percentage of hydrated lime is about three times this figure. For example, in a 1:2:4 mixture the maximum percentages of admixtures to be recommended are about 4% of celite, 8% of kaolin, and 12% of hydrated lime, by weight of the cement. The improvement in workability which is effected by these maximum additions is about that which should be expected from a 25% increase in the cement content. Larger amounts of the admixtures than those specified above may be used in cases where the highest obtainable strength is not of prime importance.

With reference to chloride admixtures, there is no doubt that those are coming rapidly into general use, and there is no count against them, so far as we are aware, in plain concretes and mortars. Those preparations which also improve the workability of cement mixtures have an added value, over and above that of their accelerating properties.

SUPPLEMENTARY STATEMENT IN REGARD TO THE MEASUREMENT OF WORKABILITY

As stated in the foregoing discussion, the penetration test for workability has served a useful purpose, but it has a number of defects. In the first place it is an indirect test measuring only the comparative segregation and lubrication in different mixtures, in an arbitrary and meaningless system of units. Second, it is lacking in desirable precision, and the average results from a large number of tests must be taken in order to insure a reasonably accurate rating for the admixture. Third, it is not applicable to a study of the effect of different coarse aggregates, except within a narrow range of gradation.

It is possible that the penetration test may be improved in such manner as to eliminate some of the above mentioned objections, but in the light of further experience with the test, we are inclined to attack the problem anew along entirely different lines. The incentive for getting a satisfactory general solution for this problem lies in the fact that some very important uses of portland cement depend for their success upon maintaining a definite degree of plasticity while other properties are being changed. We believe also that specifications for important concrete construction will some day contain requirements for workability—not, however, the quality indicated merely by the slump or the flow test.

See Institute Convention digest, beginning page 113.

¹A Penetration Test for the Workability of Concrete Mixtures with Particular Reference to the Effects of Certain Powdered Admixtures, by J. C. Pearson and Frank A. Hitchcock, Page 276, Vol. 23, Part II, A. S. T. M. Proceedings, 1923.

Economy in Handling Materials in Brick Manufacture—Baltimore Plant

BY CHARLES B. BRYANT
PORTLAND CEMENT ASSOCIATION
WASHINGTON, D. C.

What is probably one of the best equipped concrete brick plants in the country is operated in Baltimore, Maryland, by the Arundel-Shope Brick Co. Organized in the spring of 1922, through the efforts of L. L. Wagner, now its president, the corporation has grown rapidly. Upon incorporation, the company obtained control of the Shope process patent rights¹ for concrete brick making in the Baltimore territory, and erected a plant on the waterfront. Since the first brick were made, there have been many changes in the layout of the plant, none of them changing the product, but all effecting economies in production, until now the plant is operating efficiently. The company has a daily manufacturing capacity of about 70,000 face and common brick, and is having no difficulty in disposing of them.

One of the most fundamental and important considerations in the manufacture of concrete products, and one which is frequently entirely overlooked or slighted as being of minor importance, is the problem of handling large quantities of material in an economical manner. In a moderate-sized products plant, say a brick plant of 50,000 daily capacity, the daily output weighs 250,000 lbs. This material must be handled once from cars or barges into bins, again from bins through measuring boxes into mixers, a third time from mixers to machines, a fourth time from machines to racks or cars, a fifth time into curing rooms, a sixth time from curing rooms to storage piles, and a final handling into delivery trucks. The problem has large proportions. In the plant which has been assumed, 250,000 lbs. of material are moved seven times per day, or a total of 1,750,000 lbs. transported from one place to another. A small mistake in material handling will make a big difference on the balance sheet of the company. Because of the efficient and ingenious means by which the Arundel-Shope Brick Co. has attacked this problem, the plant layout and methods are of unusual interest.

¹Shope Brick Co., Portland, Oregon.



FIG. 2—VIEW OF PLANT FROM WATER—BARGES OF SAND ARE ANCHORED DIRECTLY IN FRONT OF DERRICK WHICH UNLOADS TO STORAGE PILES SHOWN. SAND IS RECLAIMED AS NEEDED AND DUMPED INTO HOPPER-BIN OVER MIXERS, AT LEFT

FIG. 3—DUMPING CEMENT INTO BOOT OF ELEVATOR TO BE LIFTED INTO CEMENT BIN OVER MIXERS. BAGS ARE CLEANED IN CLEANER AT RIGHT AND THEN BALED FOR SHIPPING

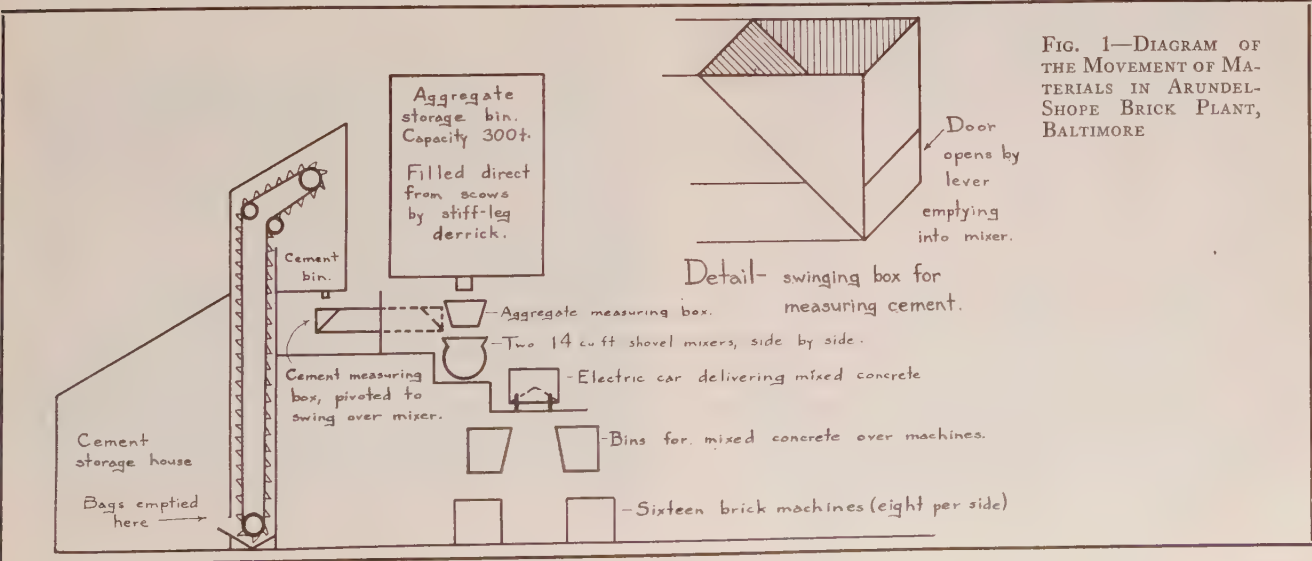


FIG. 1—DIAGRAM OF THE MOVEMENT OF MATERIALS IN ARUNDEL-SHOPE BRICK PLANT, BALTIMORE

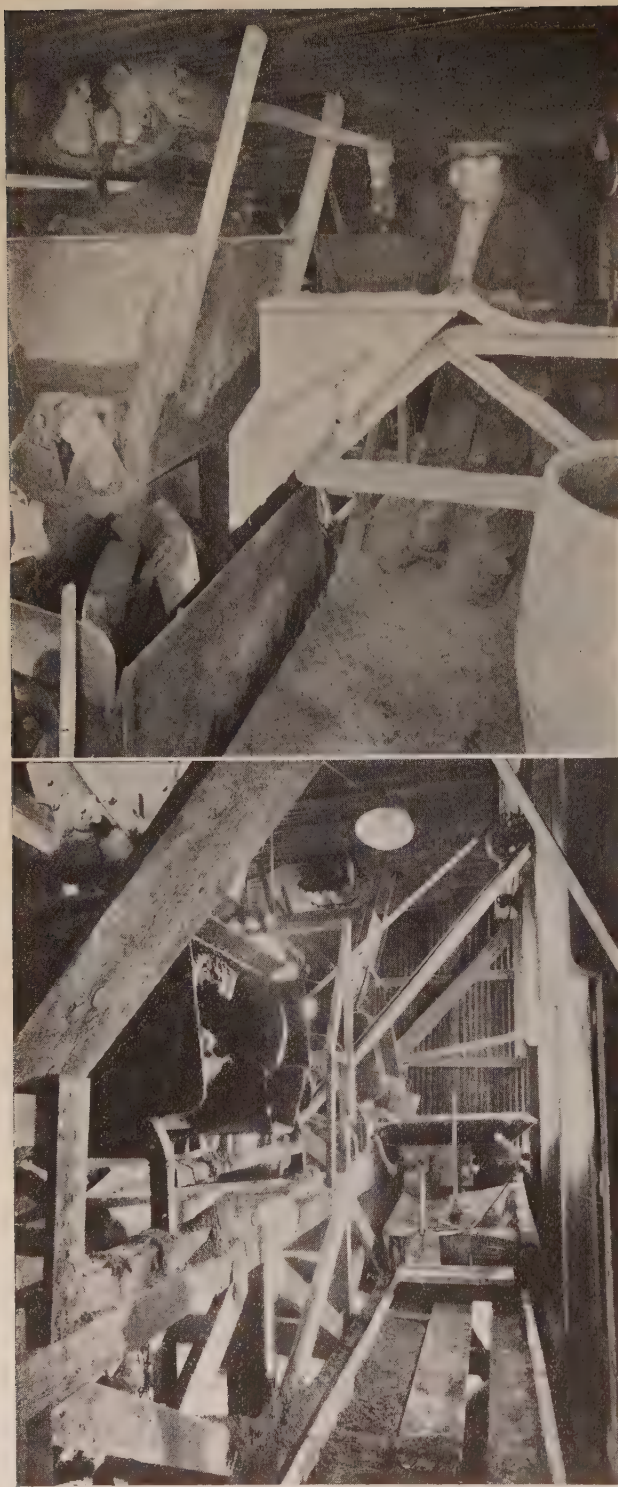


FIG. 4—MIXER PLATFORM—SAND IS RECEIVED THROUGH VALVES IN BOTTOM OF HOPPER DIRECTLY INTO MEASURING BOXES, WHICH IN TURN, DUMP DIRECTLY INTO MIXERS BENEATH. OPERATOR HAS RIGHT HAND ON VALVE OPERATING LEVER AND LEFT HAND ON TWO CUBIC FOOT CEMENT MEASURING BOX, WHICH SWINGS FROM ITS FILLING POSITION UNDER THE CEMENT BIN AT EXTREME RIGHT INTO ITS DISCHARGE POSITION (SHOWN) OVER THE MIXER

FIG. 5—CONCRETE DELIVERY PLATFORM—BOTH MIXERS TILTED INTO DISCHARGE POSITION. HOPPER DUMP-CAR SHOWN IN POSITION TO RECEIVE MIXED CONCRETE FROM FARTHER MIXER

The cement handling of the plant, which often requires a carload of cement a day, is accomplished at a very low cost. The delivery of bagged cement from railroad cars, half a mile distant into the storage, room at the plant, is done by a contractor at 10 cents per bbl., which includes loading bags from car to truck, trucking and unloading at the plant. The

method of this delivery which was devised by Mr. Wagner, is as follows: In the bottom of the delivery truck are placed three roller conveyors, rollers up. On these rollers are laid planks to make a false bottom, which rolls from the truck when the dump body is slightly inclined. In the freight car a similar roller platform and set of planks is located. In operation, two men at the car load the platform there, while the truck is on the road. As soon as the truck arrives at the car, the loose boards are taken from the bottom and the loaded boards are pushed into the truck, rolling easily over the conveyors. The truck is fully loaded in a few seconds and leaves, while the men at the car begin piling up a new load of cement. The load of cement is prevented from sliding out of the truck by the use of wooden chocks in the rear of the load. This was found more satisfactory than a tail gate. At the plant the truck backs up to an inclined platform, and the load is deposited on this platform, which has sufficient slope to slide the loaded planks to the floor of the storage room. In this way the truck is always moving, and the men at either side of the operation are always working. The elimination of idle labor and machinery is responsible for the economy of the operation.

For the remainder of the operations of proportioning, mixing and delivering concrete to the brick machines, reference should be made to the diagram and to the illustrations from photographs. Cement is dumped into the boot of a bucket elevator, which raises it to a bin overhead. Aggregate is taken directly from scows by a stiff-leg derrick, and loaded into the overhead storage bin, which holds about 300 tons. The proportioning of the concrete is effected economically and accurately by measuring boxes. Directly under the aggregate bin is a drop-bottom measuring box for each of the two mixers. This box is kept filled and ready to discharge into the mixer. The cement measuring box is ingenious and effective. Of necessity the cement bin had to be to one side of the aggregate bin, and that introduced the problem of transferring the cement to the mixer without undue delay or effort on the part of the operator. The swinging measuring box has solved this problem satisfactorily. The box is filled from the valve under the cement bin, and is then swung around over the mixer with a minimum of effort. A touch on a lever empties the cement box and the aggregate box into the mixer, the time between the emptying of the mixer and its filling being a matter of not more than five seconds. This means that both mixers are working a large part of the time, and that ample mixing is assured. The mixers discharge directly into an electric car, which dumps

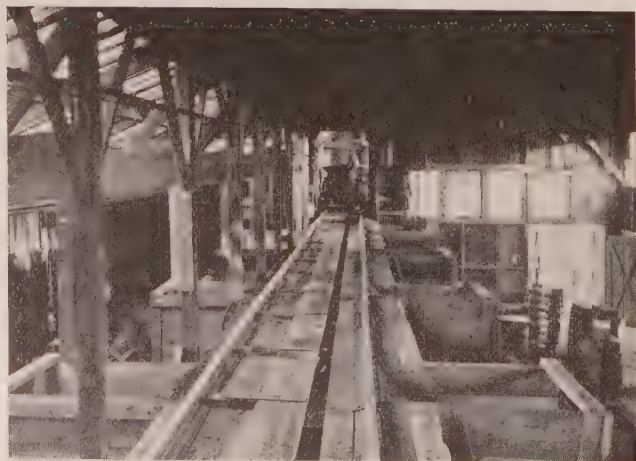


FIG. 6—UPPER PORTION OF MACHINE ROOM—SHOWING DELIVERY TRACK OVER MACHINES AND BINS TO HOLD MIXED CONCRETE



FIG. 7—PARTIAL VIEW OF ONE SIDE OF MACHINE ROOM—DUPLICATE EQUIPMENT ON OTHER SIDE OF TRACK PLATFORM. SHOWS METHOD OF STACKING BRICK ON SELF-RACKING PALLETS, AND METHOD OF HANDLING INTO CURING ROOMS ON CUSHION TRUCK AT RIGHT.



FIG. 8—TYPICAL MANUFACTURING UNIT—MATERIAL BIN AT RIGHT. ALL TOOLS, FACING MATERIALS, ETC. ON TABLE AT LEFT. OPERATOR IS PUTTING FINISHING TROWEL ON A PALLET OF FACE BRICK

on either side and runs on an elevated track over the hoppers of the brick machines. The car is operated by 220 volt, 3 phase current, and the motor runs continuously, a friction clutch serving to change the direction of travel and to start and stop. The operator of the car rides on a platform at one end. Concrete is dumped from the car into hoppers holding about $\frac{1}{2}$ cu. yd. each, beside the brick machines, from which the operators of the machines take concrete as needed.

This, briefly, is the mechanism of the concrete end of the plant. Three men, one loading the cement elevator, one proportioning and mixing, and one distributing, handle 175 tons of concrete per ten-hour day.

From the machines the brick are taken on self-racking pallets to the steam curing rooms, where they remain for 36 hours. From the curing rooms the brick go to the storage yard, where they are removed from the pallets and are piled to remain until delivered to the job. Sprinklers in the yard complete the curing begun in the steam rooms. In order to reduce the cost of loading from storage pile onto truck, a honeycomb system of piling the brick has been developed, which enables a locomotive crane to slip a fork-shaped



FIG. 9—FACE BRICK STACKED ON SELF-RACKING PALLETS IN CURING ROOM—WALLS ARE OF HOLLOW CONSTRUCTION AND STEAM IS ADMITTED THROUGH SLOTS NEAR THE FLOOR

that the quality of the product be maintained. With the mechanical improvements which the last year has brought, this plant offers many valuable suggestions on economical operation.

Building Tile and Stucco

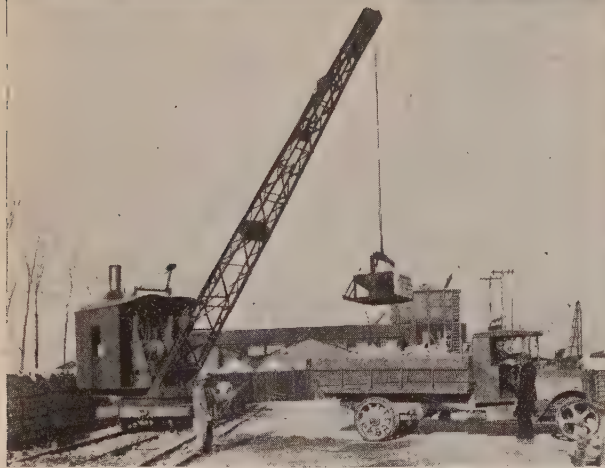


FIG. 10—FACE BRICK DELIVERY—BRICK ARE STACKED ON HEAVY OAK PALLETES HOLDING 2200. SPECIAL TRUCK BACKS BODY AROUND PILE, CLAMPS PALLET TO BODY AND AFTER TILTING PILE OF BRICK INTO POSITION SHOWN IN PICTURE DRAWS IT ENTIRE ON TO CHASSIS WHERE IT IS CARRIED TO JOB. DUMPING FOLLOWS THE REVERSE PROCESS AND BRICK ARE LEFT NEATLY STACKED, READY FOR USE

FIG. 11—ONE METHOD OF DELIVERY—CARRIER HOLDING 500 COMMON BRICK READY TO BE DUMPED INTO DELIVERY TRUCK. CARRIER IS USED IN CONNECTION WITH THE HONEYCOMB PILING OF BRICK MENTIONED IN THE TEXT

carrier into the pile and lift it entire onto the truck. Trucks are loaded quickly and at small cost.

Mr. Wagner does not regard the plant as complete or perfect, and is at the present time planning a more efficient scheme of handling brick in the storage yard. The criterion which each improvement must meet is

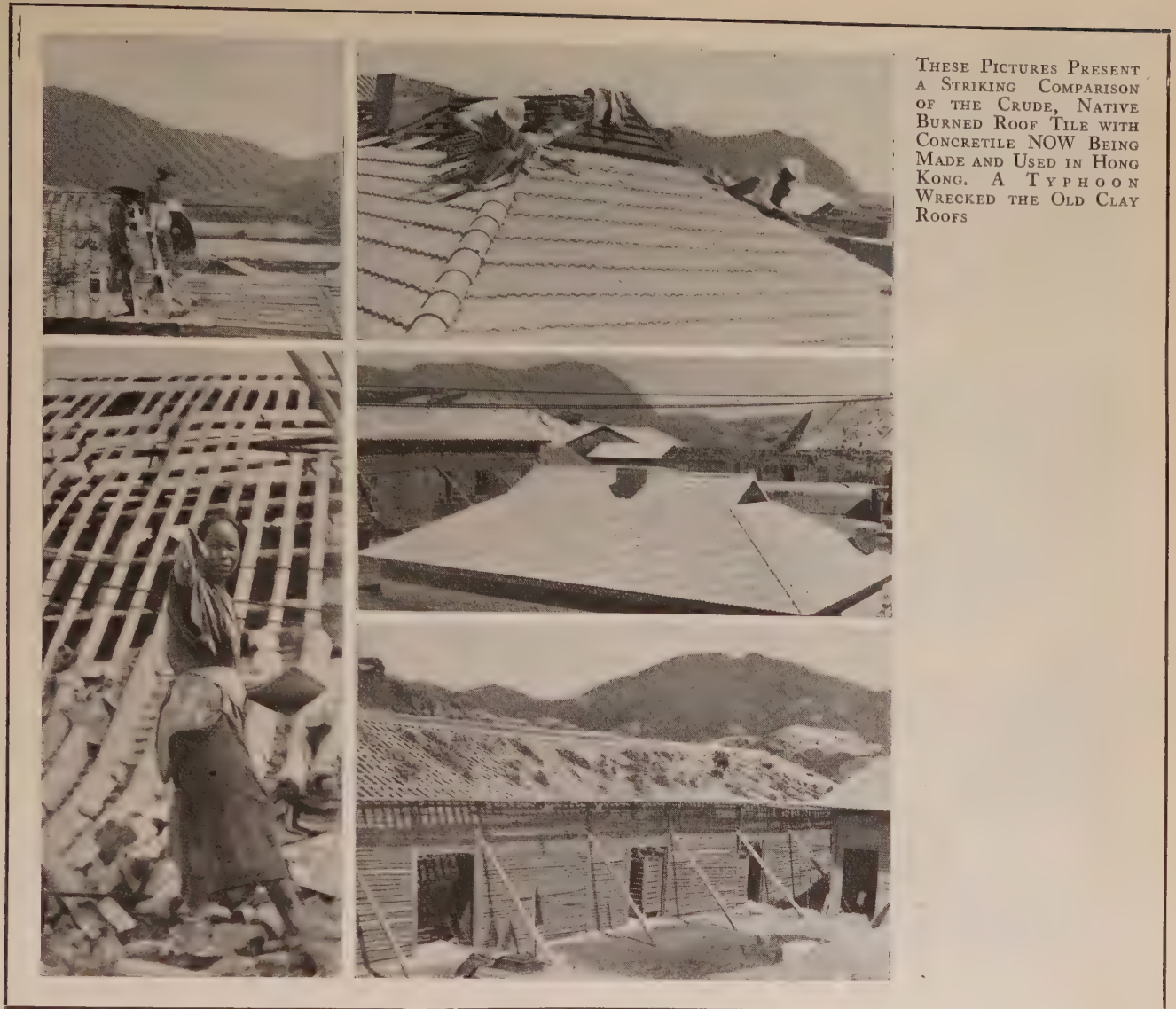


HOUSE BUILT OF DUNTILE WITH BASE OF BRICK—TILE COVERED WITH STUCCO

Look for a report of the American Concrete Institute Convention in this issue.



FIG. 12—GENERAL VIEW OF STORAGE YARD, PLANT AT EXTREME RIGHT OF PHOTOGRAPH



Concrete Brick and Roof Tile in China

BY PAUL J. HAWKINS
CRAWFORDSVILLE FOUNDRY CO.
INDIANAPOLIS

China has gone in for concrete roof tile and concrete brick, with American machinery and methods.

The Chino-American Industrial Development Co. is making concrete brick and concrete roof tile for the Kowloon Tong Developing Co., which is erecting 250 houses to cost about \$7,000 each, at Hong Kong, China. The houses will be of six rooms each, with two floors. They will be build of brick, and will have a concrete tile roof, similar to the sample roof shown in one of the pictures.

The roof-tile is being made white or of natural cement gray. There is such a shortage of houses in Hong Kong that all of the projected dwellings are already sold. Each house and grounds will be surrounded in the English fashion with a low wall of concrete brick. Fourteen million concrete brick will be required.

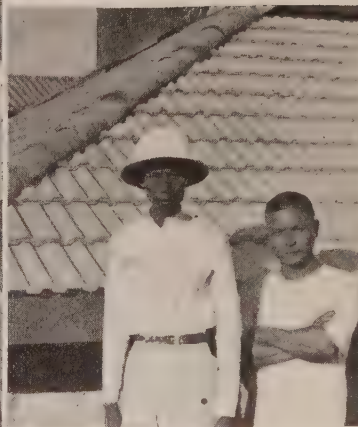
The new plant is turning out about 11,000 brick per day, with Anchor equipment, and the roof-tile plant is making on an average of 3,000 tile per day, on their six Walter Concretile machines, or 20 roofing squares.

Tile makers are employed on piece work, and each makes 500 roof-tile in ten hours. All of the sand used for the roof-tile is being transported to the plant by Chinese women, who bring it in baskets hung over their shoulders. About 100 women are kept busy carrying in this sand from a nearby mountain, and there is no road to the sand pit. In spite of the labor in getting this sand, roof-tile are being made at a factory cost of about \$5.00 per square.

Clay roofing tile in China is very expensive, extremely heavy, crudely made and difficult to lay. Practically all tile roofs are laid over poles of the open construction type. Concretile is proving very satisfactory, because it goes on faster than the Chinese tile, is more attractive on the roof and can be made at about one-half the cost of the native clay tile. Clay products are expensive because of the shortage of fuel necessary to burn them in crude ovens.

Accompanying pictures compare clay and concrete tile roofs. The sample Walter Concretile roof was laid over open construction, and pointed up and sealed

CONCRETE BRICK AND
ROOF TILE PLANT IN HONG
KONG, CHINA, AND THE
WORKMEN



with mortar from the under side. A hose stream under high pressure was used as a test against the under side of the roof to prove to the Chinese that no water could be forced through the tile. This test was convincing, although it rains from the other side in China as elsewhere.

The six-machine concrete roof-tile plant was operated by six tile makers, two men feeding the Blystone concrete mixer and placing concrete at the machines, two men knocking the tile off the pallets and stacking in the sheds, and one man making special tile for ridges, etc.

Each tile maker has a substitute called a "learn coolie," who is available for making tile in the absence of the regular tile maker. These tile makers are all friends, and live together in a shed close to the plant.

There are great possibilities in China for concrete roof-tile. There are no wood shingles; slate and prepared roofing are unsatisfactory because they will not withstand the heat and high winds. All of the better grades of clay tile used on government buildings are imported from Europe.

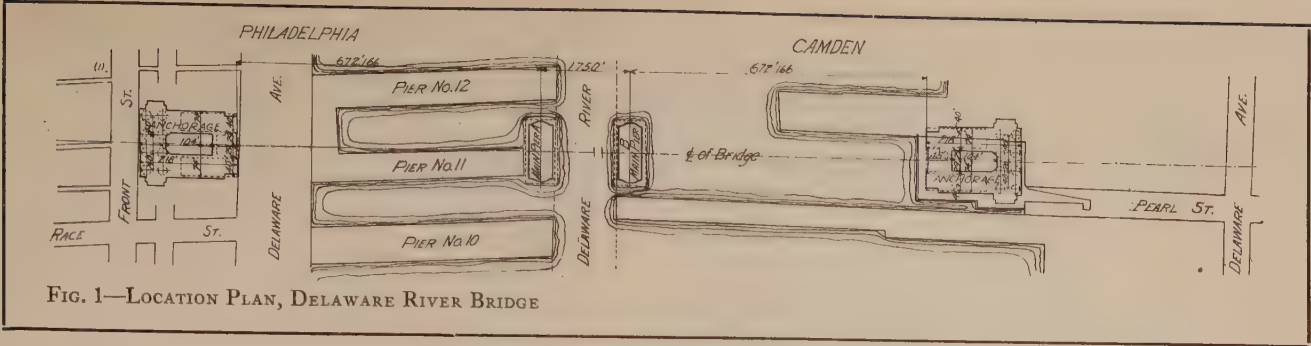
The Concretile plant at Hong Kong is the most complete and up-to-the-minute plant which we have ever helped establish. Buildings, racks and so on were built for economic handling. The new Walter portable machines and cleated pallets are being used. The roof-tile are kept under cover in sheds for ten days and well watered daily.

The first group of pictures shows the wreck of a

native clay tile roof left by a typhoon alongside the sample roof of concrete tile under construction and completed. The other group shows views of the plant and of the workmen—including the foreman (upper right).

Getting the Money for Winter Operation

There are two or three difficulties in the way that look big to the block maker so he usually decides to pass up the opportunity of all-year-round production and hibernate for two or three months. The biggest is the difficulty that materials have to be bought and paid for and payrolls must be met weekly. A stock of 100,000 block piled up in the yard means tying up liquid capital to the extent of at least \$10,000. Where is the \$10,000 to come from? Bankers are not very enthusiastic about lending money to the products man who simply needs a little more money to tide him over a hard time, but does not know where his business stands. The man whose attempts to borrow from his banker are merely apologetic appeals for help, probably meets with a very discouraging reception; but the man who can walk into his banker's sanctum and ask his cooperation in a profit-making venture will meet with very different treatment. The banker's business is done on facts and not on sentiment. In a case like this proof must be produced that there is a bigger demand than can be met by eight or nine months' operation.



Constructing Reinforced Concrete Foundations of Delaware River Bridge Anchorages

BY CHARLES CARSWELL
ASSISTANT ENGINEER DELAWARE RIVER BRIDGE JOINT COMMISSION

Reinforced concrete foundations of unusual size and character have been completed for the anchorages of the Delaware River Bridge connecting Philadelphia, Pa., and Camden, N. J. The foundations were constructed by means of reinforced concrete caissons, built over their correct locations, and sunk by open dredging to the rock 60 to 100 ft. below. Caissons of two forms, circular and rectangular, were used for the work. Both forms were designed with special consideration for possible difficulties that might arise during sinking. It is believed that the rectangular caissons are the largest concrete caissons ever constructed.

The bridge for the anchorages of which the foundations are constructed is a two cable, stiffened suspension bridge. Including the approaches on each side, it has a total length of 1.82 miles. The river crossing is a single span 1,750 ft. in length—greater than any

existing suspension span. Over a channel width of 800 ft. in the central portion, this span affords a clearance of 135 ft. above mean high water. The suspended structure has an extreme width of 125 ft. and provides a vehicular roadway of 57 ft. clear width, with two lines of trolley tracks on each side. Footwalks are provided above the level of the main deck, over the outer lines of trolley tracks.

The two anchorages are each located 672 ft. from the center of the main towers; the Philadelphia anchorage being between Delaware Avenue and Front Street, and the Camden anchorage west of Delaware Avenue, between the street and the pierhead line of the river. The anchorages are similar in design, and are each 218 ft. long and, for their main portion, 148 ft. wide. Elevator towers are provided for access of pedestrians to the bridge, and are made architectural features of the anchorages. The extreme width at these towers is 192 ft. The supporting of these towers was handled as a separate problem apart from the general foundations, and is not included in the work described in this article.

SUBSURFACE CONDITIONS

Subsurface conditions at the anchorage sites were carefully investigated by borings preliminary to the designing of the foundations, and were of importance in determining the character of foundation used. The conditions at both sides are similar. Rock is located at approximate elevations -65 ft. in Philadelphia and -100 ft. in Camden. In both cases the hard bed rock is overlaid by a micaceous schist of gradually increasing hardness from the top downward. Above this mica are strata of sand and mud, and, in Camden, a layer of blue clay. Rock foundation was determined upon as necessary for security and stability. Examination of the cores recovered from the borings indicated that satisfactory foundation could be secured within the micaceous schist. Open dredged caissons of reinforced concrete were selected after extensive investigation of possible alternative types, as the most economical and satisfactory foundation.

ARRANGEMENT OF CAISSONS

The caissons are located as shown in plan in Fig. 1,

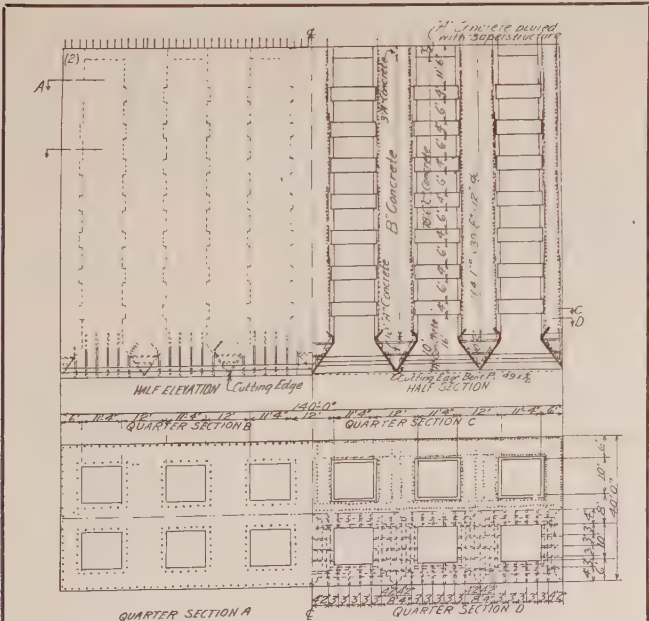
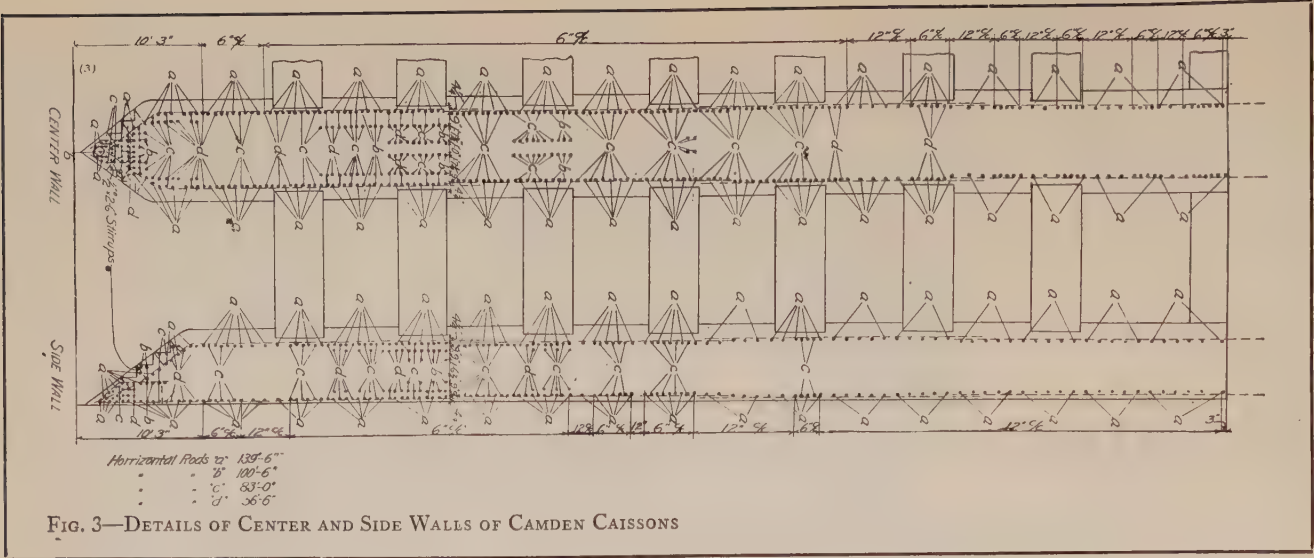


FIG. 2—CAMDEN RECTANGULAR CAISSONS AS SHOWN IN CONTRACT DRAWINGS. CAISSONS WERE SUNK 6 TO 8 FT. DEEPER THAN ANTICIPATED



with two large rectangular caissons at the forward or river end, and with eight circular caissons at the rear end of each anchorage. The rectangular caissons are each 125 ft. long and 40 ft. wide for the Philadelphia anchorage, and 140 ft. long and 40 ft. wide for the Camden anchorage. The circular caissons are all 20 ft. in diameter. The tops of the caissons in Philadelphia are located at elevation -5.0 ft., with the exception of the rear row of circular caissons, which are at elevation -4.5 ft. These elevations are fixed to suit the grade of the street adjacent to the anchorage. In Camden, the tops of all the caissons are at elevation -3.5 ft.

It was contemplated from the evidence secured by the borings, that the Philadelphia caissons would be founded at about elevation -65 ft. and the Camden caissons at about elevation -95 ft. The Philadelphia caissons were founded at from elevation -61 to -63 ft.; but in the case of the Camden caissons it was found necessary to sink to from elevation -101 to -104 ft. in order to secure satisfactory rock.

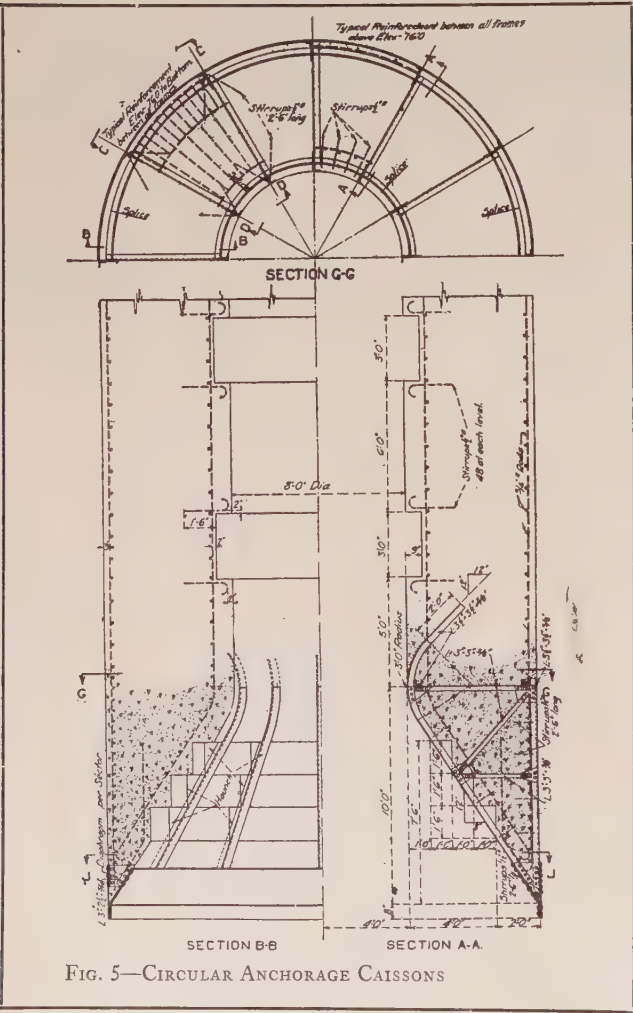
The volume of work in the foundations was as follows:

	Cu. Yds.	
	Philadelphia	Camden
Concrete.....	27,500	51,400
Open pit excavation.....	7,800	950

The pressures brought upon the foundations by the anchorage masonry are not uniformly distributed over the foundation area. The masonry above the caissons is arranged in two principal masses; one at the forward end, which supports the thrust produced by the deflection of the cables from the nearly horizontal angle at which they enter the anchorages to the angle required for their attachment to the anchor girders; the other at the rear end, which resists the uplift of the cables. The action of these forces produces a "toe" pressure at the forward end of the rectangular caissons. Because of the greater depth, these pressures are slightly higher in Camden than in Philadelphia. Under the maximum loadings for which the bridge structure is designed, the "toe pressure" has an extreme value of 24 tons per sq. ft.; under maximum probable operating conditions, it will amount to about 20 tons per sq. ft. The pressure beneath the circular caissons has its maximum value when the bridge structure is only partially completed, and amounts to 25 tons per sq. ft.; this pressure diminishes as the construction of the suspended structure advances.

RECTANGULAR CAISSONS

Each of the rectangular caissons had 12 dredging wells, 10 ft. wide x 11 ft. 4 in. long, arranged in two rows of 6 wells each on either side of the longitudinal center line. The outside walls were 6 ft. thick, and the central longitudinal wall was 8 ft. thick in each caisson. The interior transverse walls were 12 ft. thick for the Camden caissons and 9 ft. thick for the Philadelphia caissons. The arrangement of the wells was designed to provide means for controlling the caissons during the sinking, and no difficulty was found in keeping them accurately over their locations. The wall thickness was designed to provide the maximum practicable weight during sinking. The outside walls of the caissons were vertical. At the bottoms of



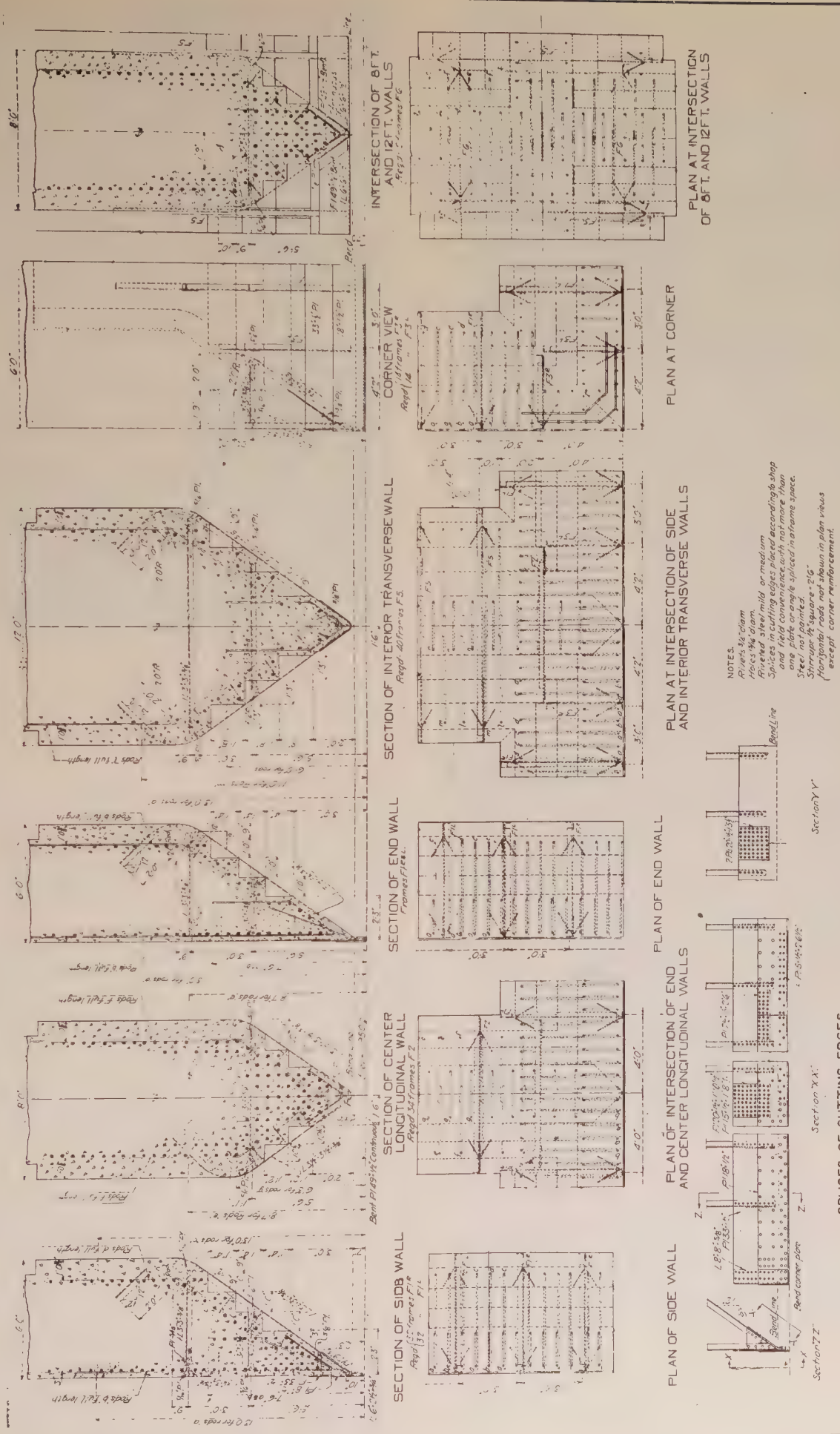


FIG. 4—TOES AND CUTTING EDGES OF CAMDEN RECTANGULAR CAISSONS

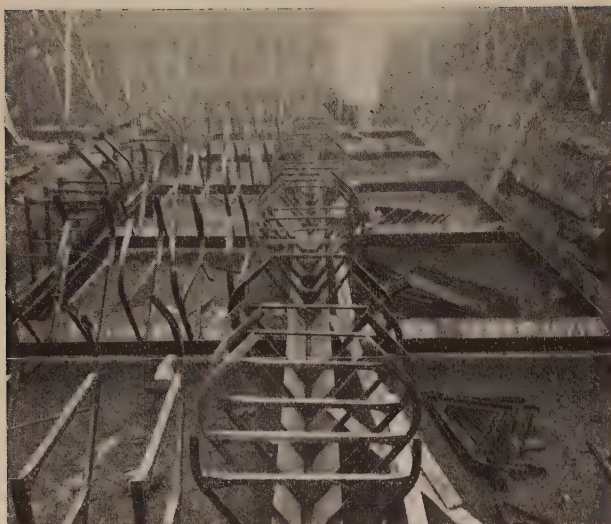


FIG. 6—CONSTRUCTION OF STEEL CUTTING EDGE FOR NORTH RECTANGULAR CAISSON FOR PHILADELPHIA ANCHORAGE

FIG. 7—CUTTING EDGE OF SOUTH RECTANGULAR CAISSON AFTER SINKING

FIG. 8—WORST CONDITION OF CUTTING EDGE AFTER SINKING. NORTH RECTANGULAR CAISSON IN CAMDEN

the wells, the inside walls flared out to meet one another and form V-shaped cutting edges. In the flaring portions, the concrete was "stepped" or recessed to provide positive vertical bearing between the walls and the concrete with which the wells were filled, and also to permit the use of blocking to support the caisson during construction. General plans and sections of the Camden caissons are shown in Figs. 2, 3, and 4.

The cutting edges were made of steel plates and angles, of the total thickness of $2\frac{1}{2}$ in., the details of which are shown on drawing No. 4. This steel construction was necessary to insure sinking into the hard micaceous schist without damage to the caissons. The cutting edges were stiffened and firmly bedded into the concrete of the walls by angle frames of $3\frac{1}{2} \times 3\frac{1}{2} \times \frac{3}{8}$ angles, spaced 3 ft. o.c. The angle frames also contributed to the strength of the toes against lateral pressure, and in the flaring portion of the dredging wells protected the concrete against excessive spalling from the dredging buckets catching against the stepped portions.

Provision was made in the design of the caissons for use of compressed air in any wells in case obstructions should have made its use necessary. For this purpose, recesses 4 ft. high and 9 in. deep, and spaced 6 ft. apart, were provided in each well. Bulkheads could have been secured in any of these recessed spaces, and compressed air used in the portion below. Sinking was effected, however, without recourse to compressed air.

REINFORCEMENT DESIGN

The reinforcement of the rectangular caissons was based upon the following design assumptions:

1. That the bending moments at the center are represented by $M = \frac{wl^2}{24}$
2. That the maximum steel stress should be 24,000 lb. per sq. in.
3. That no bending would occur until the caisson had been constructed to 30-ft. height and allowed to harden thoroughly.
4. That above 30 ft. the concrete would be poured in lifts of 10 ft. each and allowed to harden before dredging, and that not over 20 ft. would be above ground.
5. That the portion below ground would receive support from full buoyancy and from skin friction of 200 lb. per sq. ft.
6. That the portion of the toe plates in contact with the concrete would act as reinforcing steel.

The bending moments $\frac{wl^2}{24}$ are equivalent to those

which would be provided by bottom pressures varying uniformly from zero at the center to twice the average at the ends, or from twice the average at the center to zero at the ends. It is thought that this is a closer approximation to the actual conditions than the more common assumption of action as a beam supported only at the ends.

The third condition that bending would not occur until after the first 30 ft. had hardened was secured by requirement of the specifications that this portion should season for 28 days before dredging was begun. The fourth condition was based on the supposition that concreting and sinking would probably alternate as rapidly as possible. Actual construction was slightly different from that anticipated, in this respect. Above the 30-ft. height, 20 ft. was added in each case before further dredging was carried on. The reinforcement design was not modified because of this change in method of construction.

The steel design was made by regarding the caissons as big rectangular beams. Bending moments were computed at the center and at each quarter point of the half length, for each stage of the construction. Extreme fibre stresses were next determined for each case, the three longitudinal walls being regarded as one wall of the combined thickness of the three walls. The height was then divided into sections of 5 ft. each. The extreme fibre stress computed from the bending moments was taken as the stress in the extreme sections, and the stress in each section nearer the center was assumed proportional to the distance of the section from the center. Steel was provided to carry the entire stress in each section, with 1-in.

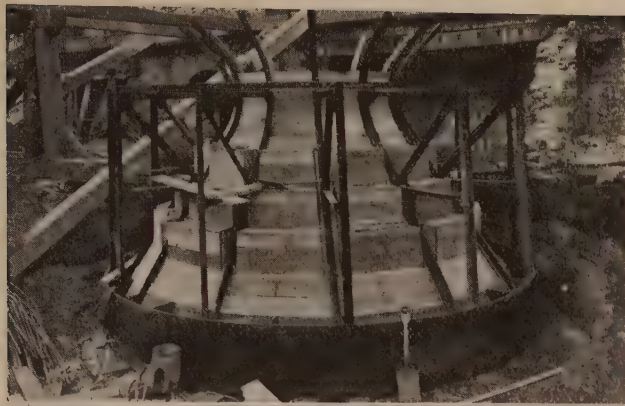


FIG. 9—CIRCULAR CAISSON CUTTING EDGE AND INTERIOR WOODEN FORM FOR FLARING PORTION OF DREDGING WELL



FIG. 10—CAMDEN FOUNDATION, SHOWING CUTTING EDGE AND INTERIOR WOODEN FORMS OF RECTANGULAR CAISSON, AND REINFORCEMENT, FORMS AND COVERINGS FOR PROTECTING CIRCULAR CAISSONS AGAINST FREEZING

square bars spaced 12 in. and placed at each side of each wall, as minimum reinforcement.

The end walls and interior transverse walls were each reinforced by 1-in. square rods spaced 12 in. o. c., along each side. For the height of 10 ft. above the cutting edges, 6-in. spacing was provided in the end walls.

The horizontal shear produced by the cable pull on the completed caissons is greater than the maximum shear from bending, and has the maximum calculated value of 75 lbs. per sq. ft. This shear is provided for, and the caissons firmly bonded together, by $\frac{3}{4}$ -in. square vertical reinforcement, as shown in Fig. 3.

FORMWORK

With the exception of the forms inside the splayed out portion of the dredging wells, which were made of $1\frac{1}{4}$ -in. timbers, all forms were of steel of Blaw-Knox construction. The exterior forms were of steel plates, stiffened with channels and angles, and were in sections, the maximum of which were 2 ft. 8 in. x 5 ft. When assembled, they provided a concreting height of 10 ft. For the first 10 ft., these forms were supported on sills on the ground, and were bolted to the steel frames of the cutting edges. At the top, the forms were held together, and their alignment maintained, by a horizontal truss made of angle chords and struts and tie rod diagonals. The truss was supported in the horizontal plane by knee-braces bearing on the lower part of the forms and tie rods to the extreme top of the forms. All tie rods were equipped with turn buckles to secure full tension and to permit of adjustment.

In order to insure the security and correct alignment of the forms through successive lifts, two lines of holes

were provided in them, one near the top and one near the bottom. The upper holes served as templets for placing bolts, with nuts attached, when the concrete was poured. After the concrete had hardened, the bolts were removed, leaving the nuts embedded in the concrete. For the next stage, the forms were raised and then supported in place by bolting to these nuts through the lower line of holes. The holes had been accurately punched in the shop when the forms were made, and in this way true vertical alignment was secured through the successive lifts.

The interior forms for the wells were 10 ft. in height, and extended from the top of one recessed section to the top of the next recessed section. This construction brought the larger part of the forms at the top, and it was not necessary entirely to collapse them for raising to the next lift. In each case they were loosened to secure a few inches clearance on each side and then raised and readjusted.

COLD WEATHER CONCRETING

Concreting was begun in December, 1922, and was carried on continuously throughout the winter. Protection against freezing was provided by heating the aggregate and water before mixing, and by heating the caissons after the concrete had been placed. At the end of the first lift, canvas covers were placed over the top of the green concrete and extended to the ground all around the caissons. Salamanders were placed inside the covers to maintain the temperature above freezing, eight salamanders being used for each rectangular caisson. The procedure was similar for the later lifts of the

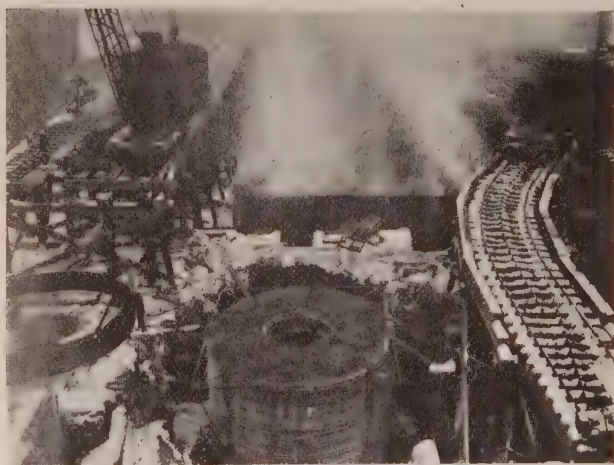


FIG. 11—NORTH RECTANGULAR CAISSON IN PHILADELPHIA BEING HEATED BY STEAM TO PROTECT CONCRETE FROM COLD WEATHER DURING PERIOD OF SETTING



FIG. 12—CAMDEN ANCHORAGE, SHOWING FORMS FOR RECTANGULAR CAISSONS

Camden caissons, the canvas covers being brought in each case to the bottom of the green concrete, and salamanders supported inside the covers. For the Philadelphia caissons, however, later lifts were heated by

steam. A pipe in which holes had been punched was placed entirely around the rectangular caisson at the bottom of the lift to be heated, and the canvas cover was brought down over this pipe. Steam passed out the holes and produced a warm, moist atmosphere, excellent for the setting of the concrete. Both methods kept the temperature of the concrete well above freezing.

DESIGN OF CIRCULAR CAISSONS

Each of the circular caissons was 20 ft. in outside diameter, with a wall 6 ft. thick and a single dredging well 8 ft. in diameter. They were reinforced by horizontal hoops of $\frac{3}{4}$ -in. square rods, and by vertical reinforcing of $\frac{3}{4}$ -in. square rods. The reinforcement was arranged close to the outside and inside surfaces of the wall. Provision for the use of compressed air was made similar to that of the rectangular caissons. Recesses 9 in. wide and 3 ft. high, and spaced 6 ft. apart, were constructed in the walls of the dredging wells. The cutting edges are similar in construction to those of the rectangular caissons. Details of a circular caisson are shown in Fig. 5.

The forms for the circular caissons were of steel, and were similar to those of the rectangular caissons. The outside forms were stiffened at the top by a truss framework forming a square. The inside forms were made 9 ft. high, with the enlarged portion for the recesses in the center of the form. The form was hinged and was collapsed for removal after the concrete had set. The caissons were protected from freezing during setting by the use of salamanders placed inside canvas covers.

The first construction stage of the circular caissons was 12 ft. high, and the successive lifts were 9 ft. each. The usual procedure was to concrete to 21 ft., to sink until the top was close to the surface of the ground, and then to continue alternate concreting and sinking. This method was not followed rigidly, however, and in some cases the caissons were concreted to 30 ft. above the ground before further sinking was done. The greater height made more weight available for sinking, and thus minimized the difficulties caused by surface friction.

CONCRETE MIXTURES

Three grades of concrete were used in the caissons, as follows: Grade A, 1:2:4; Grade B, 1:2½:5; Grade C, 1:3:6.

Grade A concrete was used in the toes of all the caissons to the height of 10 ft. above the cutting edges. It was also used for sealing the wells up to 10 ft. above the cutting edges, and for the top 3 ft. of the caissons. Grade B concrete was used for the intermediate portions of the caisson walls. Grade C concrete was used for filling the dredging wells.

SINKING CAISSONS

The sinking operation, in general, proceeded smoothly. Dredging was done by means of orange peel buckets, and the spoil disposed of as described below. Sinking of the rectangular caissons through the first 30 ft. was the most critical stage of the work, because in that period the bending stresses had their maximum values. Careful observations were made by levels as the caissons sank, and the deflections noted and controlled by dredging through the proper wells. Good alignment of the cutting edge was maintained in all cases, the maximum deflection being about $2\frac{3}{4}$ in.

On the third day of sinking the north rectangular caisson in Camden, two diagonal cracks of maximum width of about $\frac{1}{8}$ in. appeared in the lower half of the north side near the east end. These cracks could be traced on the opposite side of the wall, in the dredging

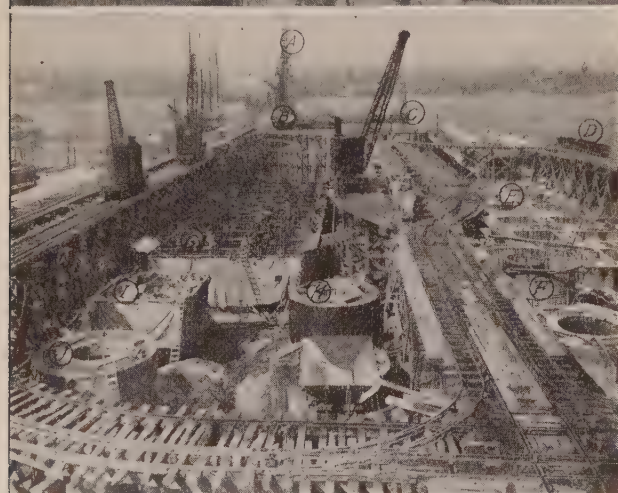
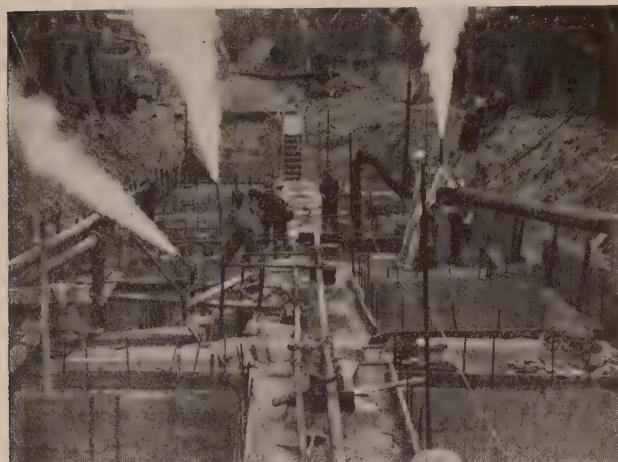


FIG. 13—SOUTH RECTANGULAR CAISSON IN PHILADELPHIA PRIOR TO SEALING. PUMPS ARE IN OPERATION TO KEEP THE DREDGING WELLS PUMPED DRY. EXCAVATION IS BEING CARRIED ON BY HAND AT THE BOTTOM OF THE DREDGING WELLS

FIG. 14—CAMDEN ANCHORAGE PLANT AND CAISSONS: (A) CONCRETE PLANT WITH HOIST TOWERS; (B) SPOIL DUMP; (C) MAIN PIER; (D) SPOIL HANDLING BUCKETS; (E) NORTH RECTANGULAR CAISSON; (F) CIRCULAR CAISSON—FORMS IN PLACE; (G) SOUTH RECTANGULAR CAISSON; (H) CIRCULAR CAISSON—FORMS STRIPPED; (I) CIRCULAR CAISSON—CONCRETE SETTING; (J) CIRCULAR CAISSON—FORMS STRIPPED

FIG. 15—PHILADELPHIA PLANT, NORTH CAISSONS, LOOKING EAST: (K) CONCRETE PLANT; (L) MAIN PIER; (M) NORTH RECTANGULAR CAISSON; (N) CONCRETE BUCKETS

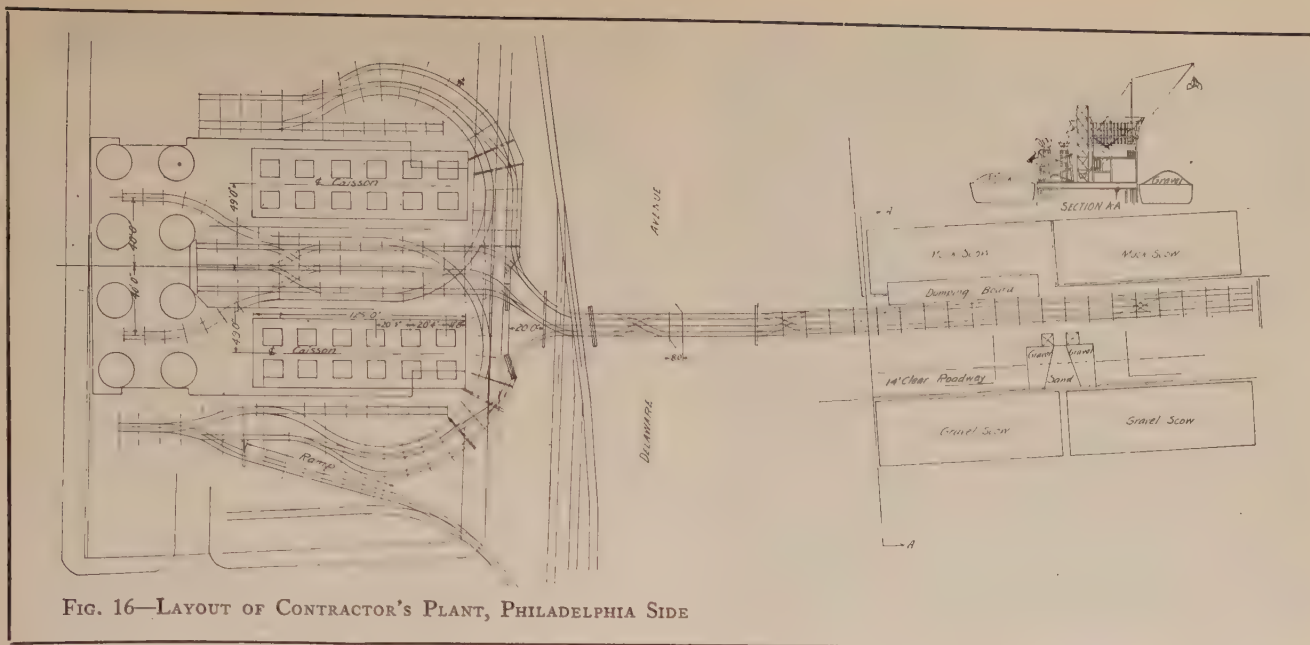


FIG. 16—LAYOUT OF CONTRACTOR'S PLANT, PHILADELPHIA SIDE

well. Dredging was at once directed to secure greater bearing in the center, and the cracks were observed to close as the caisson sank into the ground. The contractor had been permitted to commence dredging in this caisson after the top section had seasoned only 21 days. The two lower sections were then 28 days and 5 weeks old, respectively, when dredging was started. Precautions had been taken in the construction and sinking to maintain tension in the cutting edges, and thus to protect the upper portion against cracking. The sills in the center had been released first, and dredging begun there before the end blocking was all removed. Further dredging may have lessened too much the support beneath the north wall, and thus have caused extreme stresses in the section.

Sinking for approximately 50 ft. was effected by dredging by orange peel buckets through the water-filled wells. Water jets of several forms were experimented with, but were found to be of no assistance. For the lower depths, the water in the wells was pumped down, in order to reduce the flotation and thus to secure additional weight for sinking. The south rectangular caisson in Philadelphia, the first to reach this stage, had been sunk to elevation -52 ft. when it became hung up. Excavation had been carried well below the cutting edge, and examination by divers showed that the interior walls had only slight bearing, and that the exterior walls were embedded only a few feet above the edge, with the earth sloping down from this level to the bottom of the excavation in the wells. The calculated weight, with full allowance for buoyancy, was then equivalent to 850 lbs. per sq. ft. of exterior embedded surface.

After the caisson had been hung up in this position for several days, pumping out of the water was started. When the water level was lowered 15 ft., the caisson suddenly dropped about 0.7 ft. The calculated weight, for this level of the water, was equivalent to 1,050 lbs. per sq. ft. of exterior embedded surface. The bearing beneath the walls was probably not of large amount, and the jump indicates that skin friction may have been the principal factor in holding up the caisson. The value of such friction probably was not greater than 600 to 900 lb. per sq. ft. of surface.

It was found feasible to pump out the caissons completely, and this was done in each case. With the caissons thus pumped out, it was possible to clear off the foundation bed to satisfactory bearing more thoroughly

and more quickly by sending men down the dredging wells and excavating in the dry than by any available means of working through the water.

Pumping conditions were quite different on the two sides of the river. In Philadelphia, the rock surface was uneven and quite hard. When the cutting edge came in contact with it at the higher points, rock at other places was several feet lower. Partial backfilling of the wells had to be resorted to in order to cut off the flow of water from the deeper pockets. During the latter stages of the sinking, as many as four 8-in. pumps were in service to handle the ground water.

In Camden, the cutting edges sealed themselves in the soft mica rock overlying the sound rock, while the flow from higher levels was cut off by the clay stratum through which the caissons had passed. It was possible on this side of the river, to bail out the water with buckets, thus avoiding frequent resetting of the pumps as the water level was lowered. Pumps were later installed in the bottom of the caissons to handle the seepage, which was very slight.

Having the caissons pumped dry afforded an opportunity for observation of the condition of the cutting edges after the sinking. The edges were all in good condition, although in several places they showed distortion from the strains of sinking. In the second dredging well from one end in the south caisson in Philadelphia, the steel edge was cracked at one point and showed considerable distortion, with spalling off of some concrete above the edge. In one well of the north caisson in Camden, which was also the second well from the end, the cutting edge and the angle braces were distorted and part of the concrete spalled off down to the reinforcement. The illustrations show the conditions in these wells.

While the caissons were being sunk by hand excavation after they had been pumped out, precautions were taken to prevent uneven settlement of the caissons, or local injury to the cutting edges because of bearing on hard rock while the remaining portion of the walls were unsupported. For this purpose 12 in. x 12 in. timber posts were placed under the stepped portion of the walls, these posts being supported on the rock surface, where possible, or on sills. When excavation had been carried to sufficient depth that another drop of the caisson was desirable, holes were drilled in each post and dynamite inserted, and all the supports were shot out at one time.

SEALING CAISSONS

The circular caissons were sealed by placing concrete in the wells in the dry, pumping being discontinued when the filling operation started and the filling completed rapidly enough to prevent its disturbance by ground water. For sealing the rectangular caissons in Philadelphia, the wells were all drained to the central portion of the caissons, and the water removed by pumping through the central dredging wells. Concrete was placed in the dry in the drained wells, after which the pumps were removed and the two central wells in each caisson permitted to fill with water. The central wells were sealed through the water by the use of a tremie, and were then pumped out above the sealed portion. Filling in of the wells was completed in the dry.

In Camden, the water was drained from the wells in which the flow of ground water was most excessive, and these wells were filled first. The flow from the last wells was carried by a pipe connected to the pumps, and the wells sealed to the height of 10 ft. After this seal had thoroughly set, the pipe was capped and the flow of water cut off, and the remaining concrete placed in the dry. This method made the use of a tremie unnecessary.

CONSTRUCTION PLANTS

The construction plants were designed to utilize water transportation for bulk commodities, such as sand and gravel and muck, or excavated material. They were also designed to possess the flexibility needed to adapt them to the changing operations of placing concrete and removing muck, and in the later stages of the work under the same contracts, of erecting steelwork. The two plants were closely alike in their design and arrangement. Each consisted of a trestle built in three main branches, upon which standard gauge locomotive cranes and narrow gauge material trains were operated. One of the three main branches was at the center of the site, between the two rectangular caissons, and one branch was at each side. At the rear portion of the site, the trestles were arranged to give access to all the circular caissons.

At the Philadelphia side, the trestle branches came together at the river end of the site and crossed Delaware Avenue, the waterfront street, by a temporary bridge of plate girder spans supported on timber bents, to one of the city shipping piers, designated as Pier No. 11. The concrete plant and the facilities for disposing of muck were located on this pier. The concrete plant comprised storage bins for cement and aggregate, two stiff-leg derricks with about 60-ft. booms, two 1-yd. Koehring mixers, and measuring equipment. Sand and gravel were delivered to the south side of the pier by barges, and hoisted into the storage bins. Cement was delivered by truck to the street entrance to the pier. Steam boilers were located on the pier, and furnished steam for heating the concrete materials, and also, by pipe line laid over the trestle, for heating the caissons during construction. On the north side of the pier, an inclined dump board was provided at the side of the trestle. Muck was brought out on V-shaped cars and dumped directly into barges. At the rear end of the site, on the south side, connection was had by a ramp with the railroad tracks in Delaware Avenue. Locomotive cranes, reinforcing steel, and the steelwork in the superstructure were delivered by way of this railroad.

At the Camden site, railroad access was from the rear, where the trestles joined together and connected by a ramp to an industrial spur track already in place. At the river end the narrow gauge tracks were united and extended about 500 ft. to the concrete plant at

the end of a shipping pier adjacent on the south. The plant was a two-unit plant, similar to that on the Philadelphia side. It had been built for use in constructing the Camden main pier of the bridge, which was built by the same contractors. Muck was disposed of by a dump board similar to that in Philadelphia.

The entire plant equipment used on the work was usual standard construction equipment. Industrial and Brownhoist cranes were used. Excavation was handled by use of standard orange peel buckets of $\frac{3}{4}$ - and 1-cu. yd. capacity. Muck was handled in standard dump cars, and concrete in bottom dump buckets carried on flat cars.

This plant arrangement and equipment secured flexibility with a minimum of idle equipment. The cranes handled the excavation, placed the concrete, and served to shift forms and handle reinforcement. The narrow gauge trains handled spoil and concrete alternately, and in train loads of varying sizes as required.

The foundations are constructed as part of the work under bridge contracts numbered 4 and 5, contract 4 being for the Philadelphia side, and contract 5 for the Camden side. The foundations and the first sections of the masonry above the foundations are included in these contracts. Both contracts were awarded to Keystone State Construction Co., Philadelphia, and Holbrook, Cabot & Rollins Corp., New York, on the basis of their joint bid for the work. The cost of the foundations under the contract prices was \$487,236.75 for the Philadelphia anchorage and \$811,725.00 for the Camden anchorage. The work was designed and executed under the direction of Ralph Modjeski, chief engineer of the Delaware River Bridge Joint Commission and chairman of the Board of Engineers, of which George S. Webster and Laurence A. Ball are also members. Daniel E. Moran is consulting engineer on foundations.

Mother-of-Pearl Tiling

A method of forming a tile or slab with mother-of-pearl as the basic medium, in order to provide a product with a novel and beautiful appearance that will withstand wear and adapt itself to all forms of architecture and design, has been originated and patented by Albin and Caesar Vuillermet, of Philadelphia, Pa.

The method of producing the shell and cement tile or slab consists in crushing a quantity of shell, such as pearl oyster, river mussels and abalone shells to obtain therefrom the mother-of-pearl, thoroughly mixing the mother-of-pearl with a plastic mass of cement to insure the cement being impregnated with the pieces of mother-of-pearl, molding this mass into the slab or tile, grinding the surface of the slab or tile to smooth off the rough particles of cement and polish and smooth off the exposed mother-of-pearl, and subjecting the finished surface of cement and mother-of-pearl simultaneously to a coat of white demar.

The mother-of-pearl may be confined merely to the surface layer or the finished face of the tile or brick, and then, behind this, other pieces of shell mixed with cement may be used to form an integral part of the brick. If desirable, pieces of mother-of-pearl may be arranged in the molds in fanciful shapes and figures, such as star designs or fleur de lis, and a cement impregnated with the pigment used so that the complete and finished surface that will be exposed later will present an artistic finish resembling a mosaic or ceramic, and thus produce a tile that may be employed in lieu of terra cotta and used for various purposes, such as furniture tops, baseboards and border work.

Stone-Tile Made Wet in Gang Molds on Sand Beds

The accompanying pictures show the manufacture and use of Stone-tile, a concrete building unit originating in California and employing a combination of principles in concreting quite different from the common, accepted methods of building unit production.

A gang mold is employed and a wet mix, but the mold is removed almost immediately after filling. The mold in principle of operation is like a wall machine—the concrete is shaped and the mold taken away. The use of a wet mix is possible only because the principle of the sand mold is employed for taking up the excess water.

Note in Fig. 1 that bottomless gang molds are set on smooth beds of sand and filled from carts with a wet mix; the mold is vibrated, smoothed up with a hoe and struck off. A lifting device raises the mold without distorting the tile.



FIG. 1—MAKING STONE TILE

The National Stone Tile Co., San Francisco, licenses manufacturers, who are operating extensively in California. W. P. Stanton, of the parent company, says that a crew of three men—one at mixer, one at molds and one wheeling concrete and assisting at molds—can produce from 2,000 to 3,000 tile per day, depending on convenient arrangement of yard. Such a production is based on the use of a set of three or four molds, and production can be increased by bigger crews and by facilities for more rapid mixing and delivery of concrete.

From the Stone-Tile Company literature, the following is summarized.

The tile are cast directly on sand beds without the use of pallets. The yard is laid out in any desired size depending on the average



FIG. 2—LAYING STONE TILE

daily capacity contemplated. For continuous operation at the rate of 3,000 No. 6 tile per day a piece of ground 60 x 130 is sufficient, including room for stock piles.

Equipment for casting comprises a set of sheet steel molds, four molds being sufficient for a capacity of 3,000 to 4,000 tile per day of one size. Molds are furnished for two sizes of tile, the first for a unit $5\frac{1}{2} \times 11\frac{1}{2} \times 3\frac{1}{2}$ in., the second for a unit of $7\frac{1}{2} \times 11\frac{1}{2} \times 3\frac{1}{2}$ in. Used in single courses the first is for 6 in. wall, the second for 8 in. wall; walls of 12 in. or greater in thickness are built with multiple courses of these units as with brickwork. The No. 6 mold contains compartments for 15 tile, No. 8 mold for 12 tile.

The molds are arranged on the sand bed joining each other as indicated in the illustration; concrete is deposited in the molds by dumping directly on the upper surface and spreading with a hoe, leaving a small amount of surplus on top. The molds are then vibrated in a manner which settles the concrete compactly into the open cells and absorbs part of the surplus from on top. The remaining surplus concrete is continually worked ahead. As rapidly as the rear-most molds are filled and scraped off they are immediately lifted and moved forward to the next position on the sand bed.

There is no further handling until tile are piled for stock which can be done within 24 to 48 hours of casting, thus releasing beds for further casting. The different size molds are interchangeable and can be used together. The molds are so constructed with hollow partitions that they weigh only 50 to 60 lbs. apiece. It is possible to operate them by hand in the casting process; however, the equipment includes a mechanical lifter straddling the beds.

Individually, Stone-Tile units test up to the American Concrete Institute's "heavy load-bearing" classification, and the area of bearing web comprises 70% of the gross cross-sectional area of the wall. The joint bond also has characteristics which lend surplus strength.

Materials required for one thousand No. 6 tile are: 5 bbls. cement, $1\frac{3}{4}$ cu. yds. stone and 2 cu. yds. of stone $\frac{1}{4}$ in. to $\frac{1}{2}$ in.

Like brick, Stone-Tile can be laid in multiple courses, American bond, and build walls of varied thicknesses. The least web thickness is $1\frac{1}{2}$ in., and the mortar joint surfaces possess a rough texture which promotes strength of bond.

No. 6 units weigh 12 lb., air space 28%; web thickness $1\frac{1}{2}$ in.; maximum web length $3\frac{1}{2}$ in.; quantity of mortar per M to lay, 1 cu. yd. No. 8 units weigh $15\frac{1}{2}$ lb.; air space 31%; web thickness $1\frac{3}{4}$ in.; web length 4 in.; mortar to lay per M, 1 cu. yd.



FIG. 3—A CALIFORNIA
USE OF STONE TILE
WITH STUCCO FINISH

National Concrete Highway Tests

By W. S. EDGE
CONCRETE STEEL CO., NEW YORK

We have seen and heard a great deal of special test roads, notably the Pittsburg, Calif., test road and the Bates test road near Springfield, Ill. The engineers and originators who conducted these tests are to be most heartily congratulated, both on the ability with which the tests were handled and on the fine courtesy shown and assistance given other highway engineers and visitors.

A great deal was learned from these tests, and the resulting designs which have been developed are an improvement over past practice. The point that the writer wishes to make, however, is that there is a danger that the results of tests will be followed and the more widespread results of experience will be ignored.

During the past ten years or more, there has been conducted on a national scale, a highway test, the results of which are not only known to engineers but to every layman who walks or drives. Concrete roads have been built under all sorts of conditions and of various classes of concrete. Some of these have been reinforced with different types of steel reinforcement. Others have been constructed of special sections, and all sorts of experiments have been tried in the design and construction of proper subgrade support.

Many of these highways, although quite old, have never really had a traffic test until the later years of their life, and, when they were subjected to concentrated traffic, the results have frequently been disappointing. Other highways have carried a very heavy traffic from the day they were opened, so that it seems that every possible condition has been met with in actual everyday experience which could be reproduced in a concentrated test or experiment.

Any discussion of highways should take into account the probable character of the future traffic which they will be called upon to carry. It is the experience in our eastern states where traffic densities have already been reached, that, as soon as good hard surfaced roads are constructed between principal towns and cities, there is almost an immediate increase in truck and passenger bus traffic. The saturation point for pleasure vehicles seems likely to be reached soon in many localities, but for trucks and motor buses it is still far off. It is universally recognized that these two classes of traffic, particularly the former, are the most destructive agencies now operating over our highways.

If highway engineers as a class will study the actual results which have been obtained from various classes of concrete pavements, where they have been subjected to a heavy traffic, it is hard to see how they could reach any other conclusion than that our concrete roads as they have been constructed in the past are not going to give the service expected.

There are certain very noticeable exceptions to this rule. I refer particularly to the reinforced concrete pavements which have been constructed in Pennsylvania, New Jersey and New York. In many cases, particularly in the earlier pavements, reinforcement was too light to be of very much value, but the condition of the later constructions is so much superior to that of any plain concrete pavements which could

be compared to them in age and severity of service, that it is difficult to see how anyone could avoid the lesson which they teach.

It has been necessary for the writer to make an extended study of this subject, because, as soon as we started to furnish reinforcement for concrete roads, we found that there was no standard, reasonable method of design employed, that one engineer wanted 25 lb. of steel per hundred sq. ft., another wanted 65 lb. for the same conditions. One engineer wanted to reinforce the bottom of his pavement, another thought the top was the right place for steel, while still another was just as certain that the steel should be placed in the middle of the slab.

For the first year, we furnished reinforcement as required, and studied the results. The succeeding season, where we were permitted to do so, we made recommendations as to distribution of the steel, the method of placing and supporting, which in a few cases were followed. The results from these experiments were so gratifying, and our further experience was of such a confirmatory nature, that we have made bold to come forward with definite recommendations for the reinforcement of highways.

Our experience leads us to believe that, if these recommendations had been followed on the 800 odd miles of pavements we have been able to inspect to date, cracking would have been eliminated. Our experience is that a pavement should either be reinforced in the top with marginal bottom reinforcement, or reinforced top and bottom. Also that the longitudinal reinforcement is by far the more important, particularly where the divided type of pavement is employed. Corner breaking, which is the most common source of failure with plain concrete pavements, has been entirely eliminated by our method of reinforcement without the use of thickened edges.

Experience shows that concrete pavements start to fail either at transverse joints or at transverse cracks. As soon as failure starts at these points, the effect of impact is increased, and a break-up of the slab is very likely to follow soon. By heavy longitudinal reinforcement, transverse cracking can be eliminated, and transverse joints may be spaced with safety up to 100 ft. Proper doweling of these transverse joints compels the two slabs to act together under traffic, and additional transverse reinforcement adjacent to the joints prevents corner breaking. The use of a longitudinal center joint materially reduces the amount of transverse reinforcement required, and, while not necessary, results in a distinct saving in the cost of the pavement.

These results can be accomplished in many cases at no increased cost where a heavy plain concrete section has been employed; if the thickness of the road remains unchanged, the additional cost of the reinforcement will be from 20¢ to 45¢ per sq. yd. depending on the type and weight of steel employed.

The plain facts are that there are many reinforced concrete pavements, carrying a heavy traffic, from two to nine years old, which are in practically as good condition as when they were laid, and we do not know of a single plain concrete pavement of anything like this age which has had to meet the same traffic conditions, that is in nearly as good condition. In fact, many such pavements have had to be resurfaced, or a considerable amount spent on them for maintenance.

Reinforced pavements, properly designed, do not crack but maintain their original appearance, whereas the plain pavements soon become unsightly, due to the maintenance of joints.

The American Concrete Institute Convention

Of outstanding importance in connection with the 20th annual convention of the American Concrete Institute held at the Drake Hotel, Chicago, February 25-28 inclusive, were these facts and figures:

It had for the practical builder an unusually large amount of experience record as to the application of quality control methods for field conditions and requirements. This work on the field application of scientific principles of concreting represents a notable thing in the Institute's work of the last few years.

The 20th anniversary program of Wednesday, the 27th, was handled through a special committee headed by Henry C. Turner, and was characterized by a high order of scholarly achievement. Presented as a symposium with an introduction and conclusion by Richard L. Humphrey, it covered the advances in the art and science of concrete in practically every field; most of this progress being within the 20 years of the Institute's activities. The participants were: F. W. Kelley, cement; Prof. A. N. Johnson, roads; A. P. Davis, mass concrete; A. W. Ransome, mechanical equipment; Albert Kahn, reinforced concrete buildings; A. E. Lindau, bridges; M. M. Upson, foundations and water-fronts; R. F. Havlik, factory products; John J. Earley, architectural concrete; Prof. A. N. Talbot, engineering research; Prof. Duff A. Abrams, making good concrete.

This review symposium was illustrated by an exhibit of unusual excellence. It was arranged in the French room, across the corridor from the ballroom where the meetings were held, and represented the thoughtful labors of each man on the symposium program, coordinated and directed in the most effective composite by a sub-committee of the 20th anniversary committee, on which John J. Earley, A. W. Stephens, and A. J. R. Curtis accomplished the arrangement of hundreds of details on the day preceding the opening of the convention. Models, photographs, charts, diagrams, and samples of concrete, with numerous pieces of technical apparatus, visualized the progress in each of the departments into which the symposium was divided.

It was the largest Institute convention since the very early days of the National Association of Cement Users, when the block maker was ascendant and dominating in force of numbers.

It is interesting, therefore, that in these days of a greater concrete building unit ascendancy, with an increasing proportion of the output in the hands of a higher type of producer than in most cases in the old days, the products men are again becoming a considerable factor in the Institute, ranking in their application to technical problems which are as important in the products plant as elsewhere, with the engineer and the more forward of the concrete contracting fraternity, who long have recognized the existence of problems in concreting which it could be hoped would yield only to concerted study.

The registered attendance—and on the third and

fourth days there were many Chicagoans at the meetings who did not register—was 517—nearly double the registration at Cincinnati a year before.

More than 300 banquet tickets were sold, and 286 sat down to the banquet, which failed absolutely in attaining that dreariness against which many are accustomed to fortify themselves—all banquets these days are *supposed* to be dreary. The food and music were good—the song-leader's efforts were not in vain—the toastmaster, Dr. W. K. Hatt, past president of the Institute, was happily reminiscent and diverting—and the speakers, Col. Charles R. Gow, Boston, B. F. Affleck, Chicago, and Col. George T. Buckingham, Chicago, divided the after-dinner period with consideration for each other and amusement and inspiration for their audience. William M. Kinney, as chairman of the sub-committee on banquet, is largely responsible for the success of the banquet arrangements.

Frank C. Wight, chairman of the Wason Medal committee, presented the 1923 medal to John J. Earley, Washington, D. C., for his paper, "Building the Fountain of Time." The award had popular approval, not only because of Mr. Earley's paper, but because of the recognition of its author as an artist and craftsman whose contributions to concrete architectural achievement are not only in themselves noteworthy, but represent a gift in the higher craftsmanship which constitutes an advance of an entire industry.

There were special sessions for concrete products manufacturers and for concrete construction superintendents, at which they got close to the intimate problems of the factory and the job. R. F. Havlik, with four assistants from Moosehart, gave a demonstration of ornamental work processes, the interest in which extended far outside the field of the ornamental worker. There were motion pictures of house building and of stucco work of interest and practical importance.

The secretary reported increase in the organization's technical activity, improvement in finances, and steady gains in membership: from 426, February 1, 1920, to 1247, February 28, 1924.

A. E. Lindau, Chicago, was elected president to succeed W. P. Anderson, Cincinnati, who has given two years' service in the office; M. M. Upson, New York, was re-elected vice-president for two years; E. D. Boyer, who was re-elected director from the New York district, being the senior member of the Board of Direction, automatically succeeded Mr. Lindau, to complete an unexpired term as vice president; N. M. Loney, New York, was appointed to the Board to succeed Mr. Boyer; C. E. Nichols, Boston, was re-elected director for the 1st district; and Arthur S. Bent, Los Angeles, for the 6th district; Harvey Whipple was re-elected treasurer, and the Board reappointed him secretary.

It is manifestly impossible to present more than an outline of the convention in the pages of this magazine, and digest but a few of the papers and reports.

How Structures Withstood the Japanese Earthquake and Fire

H. M. Hadley, district engineer, Portland Cement Association, Seattle, Wash., presented a paper based upon his observations in the east central portion of the main island of Japan most seriously affected by the earthquake of September 1, 1923. The paper contains a review of the behavior of structures of the several building materials under the test of earthquake and fire, including a summary as to wood, brick, structural steel, and reinforced concrete. The following conclusions are drawn in regard to the concrete buildings:

The only good that can result from a disaster of this character is the lesson that is to be learned from it. In the field of concrete where failures occurred, they were due to one or more of the three following conditions. (1) Inadequate foundations; (2) Violations of commonly accepted principles of engineering design; (3) Lack of rigidity of building. In general satisfactory performance was obtained only with structural steel or reinforced concrete. The concrete was of uniformly inferior character and in spite of this fact, its behavior was admirable. Skeleton construction with either material without bracing is inadequate. Firm and unyielding foundations are essential and in building construction the use of reinforced concrete walls is the simplest, best and cheapest insurance against earthquake damage.

Observation indicated that in the case of steel structures the steel needs fireproofing and where steel structures were stiffened with concrete walls, the structures withstood earthquake shock but where stiffened with brick walls, the results were not satisfactory, walls being cracked and the bricks forced out of place.

In general, the Japanese cement was found very good but the aggregates used in concrete construction are such as would be rejected in this country. The large aggregate is river gravel containing a large percentage of silt.

Joseph S. Ruble, of H. K. Ferguson Co., Cleveland, also presented a paper describing the effect of the Japanese earthquake on various types of structures, and a number of additional interesting points were brought out as to the behavior of structures in the earthquake zone. Shock was reported to have been greater in solid ground than in soft ground in a majority of cases, and most damage was done to structures where two different types of foundations supported a single structure. Loosely laid stone walls were found to come through the earthquake better than solid walls, such as concrete retaining walls. An important recommendation, made as a result of studying the effect of earthquake shock on reinforced concrete buildings, was that in lapping steel reinforcement, the lapping rods should be laid one on top of the other, so as not to reduce the cross-sectional area of the concrete in the beam on either side of the reinforcing rod.

Old and New Methods of Constructing Concrete Bridges

Under the above heading, J. B. Hunley, engineer of bridges and structures, C. C. C. & St. L. R. R., reviewed the work done by that company in the way of concrete bridge construction since the use of stone masonry for bridge construction was abandoned about 25 years ago. Early specifications for concrete construction were reviewed, and the behavior of concrete on the earlier job discussed.

In the fall of 1922, work was begun on a relocation of line and grade revision near Sidney, Ohio, which involved the construction of about 55,000 cu. yd. of masonry, half of which was in one structure over the great Miami river. Desired strength was selected for various portions of the structure as follows: Footings and piers and abutments, 2000 lb. per sq. in.; spandrel arches and superstructures 2500 lbs. per sq. in.; arch rings, 3000 lb. per sq. in. Experiments had clearly indicated that by regulating the mix, the consistency and the grading of the aggregate, a concrete of predetermined strength could be produced in the laboratory, but there was some question as to whether by means of the crude facilities for control at hand, approximately similar results could be obtained under field conditions. As a check, 6 x 12 in. test specimens were made from time to time in accordance with the A. S. T. M. standards except that the samples were drawn directly from the discharge of the mixer instead of from the forms so that the actual slump of the particular batch could be determined. These specimens were buried in damp sand and tested at the end of 28 days. The early tests gave erratic and unsatisfactory results but it was found that the cylinders had been improperly capped and cured and when this was corrected the strength closely approximated the designed strength. A summary by groups with various fineness moduli and mixes representing 280 tests taken from the Miami river bridge are included in the paper.

The sand and stone could be easily combined in certain proportions, and the water controlled by the slump test but it was not known how much cement to use with a certain volume of sand and stone measured as they were received. To produce the desired true mix as referred to in the chart and tables of strength.

In the laboratory, a certain volume of cement had been used with a certain amount of dry rodded aggregate, producing a concrete of a certain strength. This ratio of volume was called the true mix, a purely fictitious ratio as sand had to be dealt with which contained various amounts of moisture and the sand and stone were measured while in a loose condition, neither one, nor the mixture of the two being dry or rodded. The volume of cement used with certain volume of sand to a certain volume of stone was the nominal mix but the ratio between the true mix and the nominal mix was unknown.

Various values of this ratio obtained by rather crude methods were assumed from time to time and test specimens indicated that fair success was obtained, but the determination of the factor relating the true and nominal mixes was considered the answer to the entire problem and tests by which the value of this factor might be established were made with the various aggregates used. The results were difficult to explain until a theoretical solution was found.

The particular problem is to find the relation of the true mix to the nominal mix or the true volume of aggregates to the nominal volume of aggregates. For example, taking 4 cu. ft. of sand measured loose and containing moisture, and 6 cu. ft. of stone measured loose, just as they are found on the work, the nominal value would be 10 cu. ft. If the sand were dried, mixed with stone and the mixture rodded, the resulting true volume would be less than 10 or approximately 7 cu. ft. Then for this particular mixture the ratio of true volume to the nominal volume would be 7 to 10 or 70%. If two sacks of cement were used in such a batch, the nominal mix would be 1 : 5 and the corresponding true mix 1 : 3½. The ratio of true volume to the nominal volume or true mix to nominal mix designated as *R* depends somewhat upon the size and fineness modulus of the coarse aggregate, the volume of voids in the rodded coarse aggregate, and largely upon the moisture content of the fine aggregate and the proportions of fine and coarse aggregate used. These various relations are shown graphically in figures accompanying the paper. One figure shows the relation of volumes of dried aggregates mixed and rodded to sum of aggregates measured loose. Another figure shows the relation of volume of loose wet sand to volume of dry

rodded sand; while the third figure shows graphically the relation of true mix to nominal mix.

In order that engineers for the C. C. C. & St. L. R. R. may more easily become acquainted with the methods of designing and making concrete mixtures, a set of instructions has been prepared explaining as simply as possible the effect of variation in quantity and quality of the ingredients with typical examples of mixture design worked out for them. These instructions are appended to the paper.

New Practice of Iowa State Highway Department Control of Quality of Concrete

In a paper on weighing concrete aggregates on highway pavements, R. W. Crum related some of the experiences in weighing concrete aggregates upon two concrete paving contracts in 1923, which led the Iowa highway commission to adopt the actual weighing of aggregate on road pavement construction as standard practice.

No startling revolutions in result from these two jobs was noted but concrete as good or better than other concrete made of the same materials was produced, and some improvement in uniformity was noted. After the next construction season, much more extensive data will be available from the construction of the 1924 program and from cores to be cut from this year's work. The commission's experience has been entirely satisfactory and the following facts are evident:

1. The method entails no added cost.
2. No loss in time or decreased production occurs.
3. Weighing is admittedly a much more accurate way of measuring granular materials than by loose volumetric measurements.
4. A valuable record of the amount of materials used is secured.

While it is not claimed that in theory weight measurements are any better than volume—for if all the characteristics are known, the proportions can be specified in either way to yield the same results—it is believed that measurements by weight will be better done and more consistently accurate.

Another important factor in the uniformity is the moisture content of the aggregates, especially in sand. The variations in moisture content have a large bulking effect upon the sand and therefore a corresponding effect upon volumetric measures. If the proportions are based upon dry materials, changes in moisture will be on the safe side and the concrete will be richer and the contractor will be out some extra cement but the concrete will not be uniform. By using weights, corrections for moisture can be easily and frequently made.

A valuable result from weighing the materials is an accurate record of the amount of materials actually used in the structure. Since such materials are customarily bought and sold by weight, such a record should be of great value especially to contractors. As in the case of moisture variation, other conditions such as changes in grading may make it desirable to make slight changes in the mixture. At the present time, such changes are seldom made, but when materials are weighed, it is very easy to make changes and thus take advantage of another opportunity to produce more uniform concrete.

The weighing of the aggregate in itself is undoubtedly an improvement in the detail of measuring, but in order to secure the full benefit if possible, it will be necessary to increase care in the control of other details especially the grading of coarse aggregate, the separation between fine and coarse aggregates and the water used in mixing. It is of no avail to specify such accurate methods of measuring if the consistency is allowed to vary from dry to sloppy concrete.

As respects the separation of the fine and coarse aggregate, it was found in one case that the wide variation in the percentage of sand found in the coarse aggregate obviated to some extent the benefit of weighing. It will probably not be practicable to use a screen tolerance of less than 5%. But it is believed that a 5% tolerance can and should be rigidly enforced.

Another characteristic of coarse aggregate, especially one handled to and from large stock piles, is segregation in various parts of the pile of material varying widely in grading. This will under certain conditions cause a decided lack of uniformity no matter how the materials are measured. The particular condition under which this effect is the worst is when the mixture is such that the mortar is just barely sufficient to fill the voids in a well graded coarse aggregate. The common 1:2:4 is such a proportion. One method for curing this condition would be to have the materials furnished in several sizes and have them carefully mixed by weight as is now done in the case of asphaltic mixtures. The other which is the practice of the Iowa Highway Commission is to so design the mixture that there will be certain excess of mortar over the voids in the coarse aggregate, in which case most authorities are agreed a considerable variation in the coarse aggregate would have little effect on the quality of the concrete.

Relation Between Wall Thickness and Diameter of Concrete Culvert Pipe for Highway Use

In discussion of G. W. Hutchinson's paper on the relation between the wall thickness and diameter of concrete culvert pipe for highway use, it was cited that any decrease in the thickness of the wall of concrete culvert pipe cuts down transportation charges and aids in competition with other materials. If the culvert pipe are specified by strength, the smaller sizes can be made thinner, and for the larger sizes the thickness should be increased to compete with other material on a strength basis. The desirability of making the concrete more workable without increasing the water content, was emphasized, and as shown in the following table, it was found that 3% admixture of diatomaceous earth gave an increase of between 3 and 4% in strength of the pipe for one size, and an increase of 5 to 6% for the larger size.

The following appendix to Mr. Hutchinson's paper gives an interesting summary:

Considerable of the variation in the crushing strength of concrete pipe is on account of segregation of the concrete aggregate and a tendency toward porosity, due to the drier mixtures being difficult to place properly around the reinforcement, etc. The use of excess water makes the concrete more workable but at the same time causes segregation and loss of strength. Any means by which the concrete could be made more workable, without decreasing the strength, would be considerably more desirable than the present necessity of using excess water to promote workability.

After the investigation to determine the relation of wall thickness to diameter of concrete pipe, another investigation was carried on to determine the effect of diatomaceous earth, when used as an admixture to promote workability, on the crushing strength of the pipe. The result of this investigation indicates with an addition of 3% of diatomaceous earth, by weight of the cement content, an average increase of 4½% in the crushing strength was obtained at the 28-day period.

The investigation consisted of tests of 26 pieces of concrete pipe; 13 pieces using plain concrete, and 13 pieces containing the diatomaceous earth as an admixture. Due to but one set of molds being available for each diameter and wall thickness, it was necessary to vary the wall thickness each day and correct for this change. Inasmuch as the same number of pieces of each wall thickness were made with and

CONCRETE

without the admixture, and the correction was a constant, there would be no variation due to this.

The results of this investigation are summarized in the following table:

CRUSHING STRENGTH (PER FOOT DIAMETER) OF CONCRETE PIPE WITH AND WITHOUT ADMIXTURES OF DIATOMACEOUS EARTH

	Size of Pipe, inches			
	18 x 3½		24 x 3½	
	Plain	3 Per Cent Admixture*	Plain	3 Per Cent Admixture*
	4480	4147	2730	2850
	4837	4450	2373	2395
	4350	4843	2265	2213
	3757	4125	2738	2950
	4540	4887	2780	2767
	4337	4750	2038	2320
			2175	2528
Average	4384	4534	2443	2575
Per cent	100	103.4	100	105.4

*3 per cent Admixture = per cent admixture of diatomaceous earth (by weight of the cement content).

Culvert Pipe Standards

The report of Committee J-2 on culvert pipe standards was presented as a progress report only. Some tests have been made on reinforced concrete pipe, the collection of data not being complete. The chairman of the committee recommended that the American Concrete Institute continue to be represented on the Joint Concrete Culvert Pipe Committee, and the recommendation was adopted.

Roads and Pavements

Proposed tentative specifications for one- and two-course portland cement concrete highway pavements and one- and two-course portland cement concrete pavements for streets were presented in preprint form, and were adopted as tentative standards to go to letter ballot.

The question of the re-rolled bars as steel reinforcing for highway construction was raised, and the motion made to place a rider on paragraph 17 of the proposed tentative specifications for one-course highway pavements, with a footnote that the paragraph was referred back to the committee.

Drain Tile and Sewer Pipe

Proposed tentative standard specifications for concrete drain tile and standard specifications for plain concrete sewer pipe and reinforced concrete sewer pipe were presented by Committee P-7. The standards for plain concrete sewer pipe and reinforced concrete sewer pipe were adopted as tentative standards, and the proposed tentative standard specifications for concrete drain tile were adopted as tentative specifications to be passed to letter ballot.

The presentation by the committee of the proposed standard specifications for reinforced concrete sewer pipe developed discussion as to whether or not the specification defined the standards of the product sold under the specifications. The specifications were opposed by the Lock Joint Pipe Co., and it was recommended that only the amount of steel and the mixtures be specified, on the ground that load tests alone are not sufficient for specifying thickness of pipe.

Section 1 of the proposed specifications for reinforced concrete sewer pipe was amended to provide for two classes of pipe, to be known as Class A and Class B, and adopted as amended. The specifications will be published in the Institute *Proceedings*, and will be open to further criticism.

Contractor's Plant

The purpose of the report of Committee C-1 on Contractor's Plant is a general statement of the principles on which plant design depend, and to give as thorough an exposition of the principles as is possible without any restrictions as to the type of project under consideration, illustrating particular types of concrete plants applicable to certain sets of given conditions. The report, which was preprinted, was outlined by J. G. Ahlers, chairman of the committee, to include (1) Gathering information on which discussion can be based, (2) Considering the points to be studied, (3) Conclusions. In selection of plants, points to be studied are: receiving the material, handling the material, and placing the material. It was pointed out in the discussion that money spent on plants must be got back in money saved in lower costs in placing material on the job.

Measurement of and Estimating Concrete

Committee C-5 presented a progress report, outlining the work of the committee on standard methods for the measurement of concrete work. The committee, as appointed, is made up of con-

tractors, estimators, quantity surveyors, and those directly interested in a uniform method of measuring and estimating concrete quantities. Old Institute standards are being used as a basis, and such changes, revisions, and additions are to be made as are deemed necessary to bring the matter up to present-day practice. On the approval of these changes, the final recommendation of the committee will be brought up and presented at the 1925 convention.

The Economic Value of Admixtures

This paper, by J. C. Pearson and Frank A. Hitchcock, of the U. S. Bureau of Standards, was preprinted, and is abstracted more fully elsewhere in this magazine.

Concrete Floors

The proposed standard specifications (American Concrete Institute *Proceedings*, Vol. 19) for concrete floors were adopted as standard to be passed to letter ballot.

Concrete Sewers

The proposed standard specifications for monolithic concrete sewers (American Concrete Institute *Proceedings*, Vol. 19) were adopted as standard to be passed to letter ballot.

Concrete Sidewalks

The proposed tentative specifications for concrete sidewalks were presented in preprint form, and paragraph 7, referring to slag, was amended to provide that the slag shall comply with the American Society for Testing Materials standards. They were adopted as tentative specifications as amended.

Building Codes and Their Relation to the Concrete Products Industry

Building codes and their relation to the concrete products industry were discussed by N. M. Stineman and W. F. Lockhardt in a paper preprinted prior to the convention.

The concrete products section is subdivided in the paper as follows:

1. Introduction
2. Materials
3. Proportion
4. Tests required.
5. Methods for making tests
6. Standards of quality
7. Use
8. Working Stresses
9. Thickness and height of walls
10. Party walls
11. Construction
12. Licensing
13. Identification
14. Penalty

The code in the paper is the code adopted by Camden, N. J. This is a drastic code and calls for a licensing fee. An ordinance passed by the city council of Camden provides for the legality of collections of the licensing fee.

It is cited that in view of the fact that manufacturers of other building materials are not required to be licensed there may be complaint at times from the products manufacturer that his industry is being discriminated against. It may be that from some standpoints the practice is indefensible. On the other hand it must be admitted that it is possible for the fly-by-night operator to make a poor product unless there exists the power to curb him, while under such an arrangement, the reputable manufacturer gains by being able to advertise that his is the only mason material manufactured to conform to standard specifications under building department supervision.

The discussion was centered around the idea that a better quality lightweight unit is the hope of the concrete block industry. The proper kind of block can compete with other products within a radius of 100 miles.

Building Fireproof Homes

Paul Huber, architect, Huber Brothers, Syracuse, N. Y., read a paper on building fireproof homes as distinguished from fireproof houses, the paper being illustrated by stereopticon views.

Design and Construction of Concrete Dwelling Houses

J. A. Ferguson, chairman of Committee S-5, presented a progress report giving proposed substance of recommended practice for design and construction of concrete dwelling houses. The report was incomplete, as it is the aim of the committee to have the report contain, in the end, complete information for anyone who wants to build a concrete or composite house. The report was accepted as a progress report, and referred back to the committee for further study. Discussion of the subject included the possibility of avoiding repetition of basic specifications already adopted which might be referred to as such in writing the complete specifications for concrete houses.

Fire Resistance of Concrete Block

The preprinted report of Committee P-5 on the fire resistance of concrete block, is abstracted more fully elsewhere in this issue. The work of the committee has been a continuation of the work reported at the convention last year, and it was recommended that the committee be continued until the fire tests being made at the Underwriters' Laboratories are completed. Discussion of the report indicated that the Underwriters' Laboratories officials are not agreeable on the point that the influence of fine aggregate may be ignored.

The report of the Laboratories will advocate the use of concrete as a substitute for combustible material.

Analysis of walls after fire were suggested, for the purpose of noting the proportion of cracks occurring in the face next to the fire, in comparison with cracks which extend further back into the wall.

Concrete Building Block, Building Tile and Brick

The tentative standard specifications for concrete building block and building tile, and for concrete brick, as presented by Committee P-1 in preprint form, were passed as tentative for another year. A form for reporting tests of concrete building units was suggested by the committee and the report filed for further study.

Concrete Staves

Tentative specifications and building regulations for concrete staves were presented in a preprinted report by Committee P-4 and approved as tentative. These specifications are based on the study of the structural requirements of staves when used in the construction of silos, grain tanks, coal pockets and similar buildings. They are also based on data secured from a comprehensive series of tests in which staves were supplied by representative manufacturers from different sections of the country. Other tests made prior to the past year also furnished data to be used in the formulation of the proposed specifications.

A brief summary of the results of the tests made at the Structural Materials Research Laboratory, Lewis Institute, are included in the report of the committee, giving information regarding the methods and materials employed in the manufacture of staves, and giving some of the results of the absorption and strength tests. Compression tests were made on specimens cut from half staves after the transverse tests and absorption tests were made on sections cut from half staves.

A high transverse strength and low absorption are highly desirable qualities in concrete staves. The transverse test indicates the ability of the staff to resist the outward pressure imposed upon it between the reinforcing hoops of silos, grain tanks, and other circular structures used for storage purposes and a low absorption is important as it is a measure of the water tightness of the staff.

The compressive strength indicates the ability of the staff to resist forces which tend to crush it. Staves that meet the requirements for transverse strength will have sufficient compressive strength to sustain the load imposed upon them. In view of this fact, the committee did not include a compressive strength requirement in its specifications. The committee had in mind in preparing the specifications the advantage of requiring strength tests which could be made in the average plant, as such tests are valuable in regulating manufacturing processes to improve the quality of products or to lower production costs or both.

20th Anniversary Day Symposium

The 20th anniversary day program was opened by Richard L. Humphrey with a historical address reviewing the foundation of the American Concrete Institute and the early work of its founders.

F. W. Kelley's paper is presented in full in the preceding pages of this issue.

Concrete Roads

The use of concrete in road construction was reviewed by Prof. A. N. Johnson, and while the compilation of historical material for the topic was confined to the period coincident with the development of modern road construction, following the increased need for transportation by land that began to make its influence felt about the middle of the 17th century, but which did not materialize to any considerable extent in road building until nearly a century later, brief mention is also made of some of the references in ancient history to the art of road building. The paper describes the earlier uses of concrete for roads; earlier concrete pavements in America; awards for concrete roads; development of concrete road-making machinery; the development of specifications for concrete roads; investigations and researches; literature on use of concrete in road construction; and includes a bibliography of references as noted in the paper, as well as a list of books of general interest on the history of highways.

Mass Concrete

The use of concrete to simulate rock in the construction of dams, tunnels, culverts, canals and other massive structures was referred to by A. P. Davis, as a similar advance in masonry construction as was made in the use of iron when it became practical to melt and cast the metal in any form desired. The advantages of using concrete as artificial stone, and important features to be taken into consideration in its use, as mentioned in the paper, are included in the following abstract:

Although the advantages of concrete over natural stone are important as regards convenience, speed, and economy, what is probably its greatest advantage is the facility with which metal reinforcement can be incorporated as desired. This valuable quality makes concrete adaptable to a great variety of structures entirely outside the realm of natural stone.

The adaptability of concrete to the requirements of complicated and elaborate structures alluded to above, depends to a large extent on the practicability of providing and manipulating the necessary forms. Marked development along this line has been noted in recent years.

The manufacture of concrete involves a chemical process and as it is necessary to place the concrete prior to the time that hardening begins, practically all of the chemical action occurs after the concrete is in place. This chemical action generates an

appreciable amount of heat which increases the volume of the concrete and as the hardening proceeds under the increased temperature its shape becomes permanent. As the concrete contracts on cooling, there is a tendency for long structures such as pavements, walls, etc. to crack at various intervals varying with the climatic and other conditions.

Recent experience shows that the tendency to form cracks is less if the concrete is placed in cold weather so as to put the structure under compression when warmer temperatures arise. These problems are of great importance in such structures as dams, where leakage is undesirable. In the case of concrete pipe, changes of temperature in the pipe may be restricted by burying the pipe, particularly under conditions of minimum temperature.

In the case of dams, the problem of expansion and contraction has been met by building the structures in columns separated by joints normal to the faces of the structure. Alternate sections were built to considerable height and allowed to harden completely and lose their chemical heat. After the colder weather had chilled the columns built and reduced them to a minimum volume, the remaining sections were built in so that in warm weather the entire structures are placed in compression by the expansion due to increased temperatures.

One of the most efficient measures yet used is the application of the cement gun for producing water tight structures. With the aid of this machine, a concrete is produced which is dense, hard and impervious and which can be made to adhere to old concrete or other structural materials.

Mechanical Equipment

The development of efficient tools to carry out the performance of concrete work to keep pace with concrete, which has progressed during a single lifetime from a position comparatively unimportant to its present preeminence in the field of engineering construction, was reviewed by A. W. Ransome. Mr. Ransome expressed the opinion that in the concrete industry the demand for increased output, combined with the necessity for reduction of the labor involved, excited a resistless pressure for mechanical aid. This demand has been answered by the genius of the equipment engineer, with a resulting array of powerful and efficient machinery all designed and built for specific duty. It is pointed out that the adoption of the present-day equipment for handling concrete has had another equally valuable influence on the development of the art, in that the inequalities of concrete are largely removed, so that, with uniform gaging of materials, thorough mixing, and rapid distribution, the designing engineer is relieved of a great portion of the worry as to the actual strength of the concrete as it is placed in the forms. In reviewing the progress that has been made in equipment for handling and placing concrete, it is cited that, in a general way, the principles of all recent large concreting plants are the same, and the description of one might be applied to another. The interesting fact is cited that the pioneers in the mixer field, Ransome, Smith and Koehring, are the highest-priced mixers on the market. Manufacturers have to face the economic problem of how far to go in the direction of perfecting their devices. They must determine whether an expenditure looking toward improvement of their machines is justified by the service to be performed.

Reinforced Concrete Building

A very interesting paper, reviewing the activities in the field of reinforced concrete building design, was presented by Albert Kahn, and will be generously abstracted in a later issue of CONCRETE.

Concrete Bridges

A paper, by A. E. Lindau, on concrete bridges, describing how the development of reinforced concrete permitted culverts to develop into bridges, will be presented more fully in a later issue of CONCRETE.

Foundations and Water-Front

The development of the concrete pile and concrete caissons, termed "children of cheap cement" in a paper by M. M. Upson, is traced from the earliest stages to the present day. As an illustration of what is being accomplished in this line, the foundation of the bridge which is soon to unite the cities of Philadelphia and Camden is referred to.

Before the advent of the concrete pile, the capacity and size of some structures were, of necessity, limited because there was not sufficient space to accommodate the necessary number of supporting wood piles. Certain ground was considered valueless for reasons that there was no known method of providing an economical foundation. The concrete pile may be increased in size and in length to meet all practical needs. It is independent of the water line. It may act as an element to carry its load entirely by friction or it may penetrate to a substantial underlying strata. It opens up a new possibility for the harbor engineer by permitting the building of heavy storehouses on piers, which before the advent of the concrete pile, of necessity, must have been built on the adjacent shore. It is obvious that such developments have opened up a new field to the terminal and harbor designer. When all collateral costs are considered the economic advantage looms large.

A material, rotproof, fireproof, unaffected by water or dryness, structurally efficient, is presented in the concrete pile as a substitute for materials which have many or all of these weaknesses. The durability of concrete when subjected to sea water is being studied and in almost every instance where deterioration is found in sea water, it is apparent that one or more of the fundamental laws which are known to underlie the producing of a permanent concrete have been broken.

The combination of cement, aggregate and steel in the construction of bulkheads and piers has opened up virgin fields of design of the piling or sheathing to which slabs and beams are connected in a monolithic structure so that all elements unite to resist pressure to which the structure as a whole is subjected. Greater strength and rigidity are secured and economy of construction is attained. These principles scientifically applied have demonstrated in many instances that an all concrete bulkhead or pier can be constructed at an equal or lesser cost than the long-used creosoted wood structure.

The business of concrete piling aggregates over 3,000,000 lin. ft. per year which converted into wood piling equals over 7,000,000 lin. ft. Reducing the saving to terms of average timber land, it is found that 4000 acres of virgin timber are saved each year by the concrete pile industry.

The future of the industry lies in two hands, the producer and the engineer and manufacturers of cement. The producer of concrete which goes beneath the ground

CONCRETE

must rely on the manufacturer to give him the proper cement with which to work. The constructor should apprise the cement manufacturer of the service to which his material is to be put, and he in turn must know enough of his product to supply that which is suitable to the service.

Concrete Products

A paper, by R. F. Havlik, commenting on concrete products, gives statistics of the scope, growth, etc., of the concrete products industry.

Architectural Concrete

John J. Earley's paper on architectural concrete is presented in full in the preceding pages of this issue.

Engineering Research

Engineering research in concrete and reinforced concrete was reviewed by Prof. A. N. Talbot, dating back some 25 years ago and giving some impressions of the work and its meaning up to the present time. That the information obtained from various laboratories throughout the country, together with that derived from other sources, including foreign research, helped to enable the joint committee on concrete and reinforced concrete understandingly and intelligently to make progress report in 1909 and 1912, and the final report in 1916, was cited. Time has shown them, on the whole, to be sound and constructive, and to have exercised most important and beneficial influence on engineering practice in this country.

Prof. Talbot cited that research is always found to have incidental by-products. The tests of 33-ton slab beams, made for the Illinois Central R. R., in Chicago, and viewed by engineers, gave to these engineers, and many others, an appreciation and confidence in this new form of construction otherwise not easily gained.

The sight of the comparative tests of large cast iron culvert pipe and reinforced concrete pipe gave the same engineers a new idea of the applicability of this material. The early tests of buildings, the strains in the concrete and the steel being measured first, followed by Hatt and Slater and Gonnerman and Richert and others—these tests not only gave needed information on the action of the structural members of the buildings but conveyed to designer and constructor and owner a confidence in reinforced concrete that was lasting.

The work of Abrams is referred to as such that it will long remain a classic. A passing reference is made to a variety of research work of other kinds which has been carried to completion or is under way, and the conclusion is drawn that, as time goes on, engineering will be more and more dependent upon engineering science, which in turn depends upon research. Cement needs study, and reinforced concrete needs study. It is far from perfect.

Making Good Concrete

Prof. Duff A. Abrams presented a paper on making good concrete reviewing early and later methods for controlling quality. The work carried out at Lewis Institute in the Structural Materials Research Laboratory was touched upon, as well as some of the possibilities for future development.

An indication of what may be expected of concrete in the future was given in a paper by Richard L. Humphrey. A part of Mr. Humphrey's prophecy is printed elsewhere in this issue.

What Engineers and Contractors May Expect to Accomplish with High Alumina Cement

A paper, by Colonel Henry S. Spackman, on high alumina cement and its application in the concrete field is presented in full in this issue. In discussing Colonel Spackman's paper, P. H. Bates, of the U. S. Bureau of Standards, expressed the opinion that the limited supply of bauxite in the United States, one of the constituent raw materials of alumina cement, would have a tendency to limit the use of the special cement in this country. Alumina cement is now being manufactured in the laboratory at the Bureau of Standards, and further tests are to be made to add data as to its use in reinforced concrete.

Ernest Ashton suggested that there was more possibility of high silicate cements making inroads on the portland cement industry than of the high alumina cement.

Field Tests of Concrete

The following abstract from the preprinted paper by J. G. Ahlers and Stanton Walker outlines a series of tests made by the New York group of contractors, in cooperation with the Structural Materials Research Laboratory, and states the conclusion reached as a result of the investigation.

Researches into the properties of concrete have been under way for many years by several investigators in the United States and Europe; but only within the past few years has extensive and accurate information, applicable to the production of concrete in the field, been obtained. In the summer and fall of 1923 strength tests of concrete were made during the period of construction of five reinforced concrete buildings in New York City. These tests were an outgrowth of an extensive series of field investigations undertaken to establish means of introducing into practice some of the improvements in the technique of concrete making, which recent researches have indicated are desirable and to determine the practicability of securing the compressive strength desired in concrete produced under field conditions.

The first of these field investigations was planned and carried out by the Joint

Committee on Standard Specifications for Concrete and Reinforced Concrete, in cooperation with the General Committee on Contractors. The General Committee of Contractors was formed in 1921 under the joint chairmanship of M. J. Whitson, and M. M. Upson. In May, 1922, the New York Group of Contractors was appointed as a sub-committee of the General Committee under the chairmanship of John G. Ahlers, to carry out similar field investigations in the New York territory, independently of the General Committee.

Three major investigations have been carried out: two under the auspices of the Joint Committee and the General Committee, and one through the cooperation of the New York Group of Contractors and the Structural Materials Research Laboratory.

CONCLUSIONS

In applying the results of this latter investigation to the general problem of field control of concrete, the conditions under which it was carried out should be kept in mind. The tests were made on work under construction by high-grade contractors, in a district where aggregates of excellent physical qualities are used. Trained organizations of long experience and adequate equipment for proportioning and mixing the concrete as measured by present standards, were used.

The following conclusions may be stated:

1. On these five jobs, where trained organizations of long experience were used, the proportions and methods employed, based on experience only, gave concrete having an average strength from 6 to 18% greater than that assumed for purposes of design. It is noteworthy in this connection that many of the objectionable practices which account for unsatisfactory concrete, were not encountered on these tests.

2. With the concreting methods used on these jobs, it would be fair to expect a uniformity of strength such that not less than 75% of the test specimens would fall within 20% of the average strength, and not more than 5% would fall below a minimum value, computed on the basis of the Joint Committee Tables of Proportions, (also published in Bulletin 9, of the Structural Materials Research Laboratory).

3. A study of the proportions and the materials carried out in the light now available will enable the engineer to estimate within 20% the average strength of the concrete when made in accordance with the general practices followed on these jobs.

4. Estimates of the concrete strengths made for the 5 jobs on which tests were carried out when compared with the strengths obtained, show that the water ratio offers a practical basis for estimating the strength of concrete, if aggregates of suitable physical structure are used.

5. The fineness modulus is an accurate "yard-stick" for measuring the grading of aggregate for the purpose of determining the economical proportions of fine to coarse.

6. The maximum permissible values of fineness modulus given in Table 3, Bulletin 1, of the Structural Materials Research Laboratory may be satisfactorily applied to building construction. These values of fineness modulus produce concrete which works somewhat more harshly than that to which the mechanics are accustomed, and in certain cases a campaign of education may be desirable before the maximum values given by Table 3 are used. Reduction of these maximum values by 0.25 produces concrete which is easily worked into the forms in building construction.

7. Concrete designed under the conditions encountered in this investigation gave strengths well above the value in the Joint Committee Tables of Proportions.

8. The variations in strength shown by the individual specimens for different batches were, in general, the result of accidental variations in the proportions; the satisfactory agreement of different specimens from the same batch indicate that the variations were not due to the test methods employed.

9. A device which will insure a uniform quantity of aggregate from batch to batch will be of material assistance in securing concrete of uniform strength. Hoppers having vertical sides and provided with a mechanical strike-off are practicable and offer great advantages over present methods. Uniformity in the volume of sand can be maintained by the inundation method of measurement.

10. In order to secure concrete of uniform quality with the least cost for proper control, uniformly graded aggregate should be furnished throughout the course of the work. The specifications for grading should be drawn to conform to the most economical proportions for the aggregate available. It is neither necessary nor desirable to apply the same specification for grading in all cases, as concrete of the same quality can be made from aggregates of a wide range in grading and other characteristics.

11. It is not practicable to adjust the proportions on the job to compensate for variations in the grading of the aggregate which may occur from batch to batch. However, it is feasible to modify the proportions to compensate for variations in grading occurring in different scow loads or other lots of considerable size, where each lot is uniform within itself.

12. For large concrete jobs preliminary studies should be made of the aggregate at the source of supply for the purpose of determining economical proportions.

13. Scientific control can best be accomplished by using a testing organization outside that of the owner or contractor. Provision in the contract for an equitable division of the expense of scientific control, will greatly facilitate such control.

14. The experience obtained during this investigation shows conclusively the vital importance of making tests on the job to determine the strength of the concrete used. This is evident from a consideration of the definite economies which may be effected in proportioning the concrete and in designing the structure to take advantage of the known strength of the structural material employed. Definite strengths can be obtained only by: (1) rigid inspection and (2) tests of the concrete.

In discussing the subject "Field Tests of Concrete" it was stated that the Joint Committee is gathering facts for further consideration, and the work so far completed is very important in that it shows what is possible with the cooperation of contractors and engineers.

Methods Used and Results Obtained in Control of Concrete in Building Construction

In discussing tests made at the University of Illinois and at Camden, N. J., W. A. Slater, of the United States Bureau of Standards, pointed out that there is not much correlation between slump and other properties of concrete, and that there is a possibility that 7-day tests will prove more useful than the 28-day tests, in showing how accurately the work is being carried out in designing concrete mixtures. It was found that the slope of the progressive strength curves gives some measure of the condition of the specimen.

A written discussion of Mr. Slater's paper was read by W. P. Bloecher.

Suggestions for the Production of Better Concrete

The subject of better concrete is referred to by R. L. Bertin, chairman of Committee C-6 on Field Methods, in the committee report as one of vital importance to the industry, and which requires the cooperation of the scientists and those engaged in the art of concrete making to bring about its realization. The following is abstracted from Mr. Bertin's report:

Better concrete can be defined as a concrete, the properties of which are so nearly constant that they can be fully taken advantage of in design.

It is self-evident that, if concrete of predetermined and constant quality is to obtain, the characteristics of the material must govern in the determination of proportions, and methods must be used to insure constancy of operation throughout the making of concrete.

The production of constant concrete is then based on the following:

(1) A complete knowledge of the concrete making qualities of the available materials.

(2) The application of the scientific principles governing concrete to the determination of the proper combination of the available materials to result in a concrete of the desired quality.

(3) Methods of handling the materials which will maintain the established proportions and insure homogeneity of the concrete to the place of depositing.

It will be of interest to demonstrate:

(1) How far short the present specifications and methods of making concrete fall from meeting the above mentioned requirements.

(2) The fact that in almost every instance a considerable waste of money results from the utter disregard of these rules.

The popular forms of specification in vogue today are to a large extent responsible for the furtherance of the wasteful and inaccurate methods used.

They place restrictions on the gradings of aggregate which are meaningless and expensive.

They stipulate arbitrary proportions, independent of the nature of the materials, and they leave unmentioned the most important factors which control the quality and cost of concrete.

It is not generally known, but nevertheless a fact, that good concrete can be made with almost any sort of clean, sound and stable aggregate, if sufficient cement is used. The grading of the aggregate, by virtue of the fact that the amount of cement required is dependent upon it, is more a matter of economy than one of regulation. The grading of the entire aggregates (fine and coarse) which proves most economical is that which produces a mixture of particles from fine to coarse, having the greatest density or nearly so.

In general, the influence the properties of the constituent of concrete have on the quality of the resulting concrete are as follows:

The cleanliness of the aggregate, its hardness and durability are fundamental requirements.

The relation that the strength of the resulting concrete bears to the proportion, size and grading of the ingredients is:

(1) That the strength of the concrete varies in an inverse ratio to the amount of water used with a given quantity of cement.

(2) That the amount of water required to produce concrete of a given plasticity is a function of the grading and maximum size of the aggregates.

The ratio and function above referred to have been sufficiently well established to form the basis for the determination of correct and economical concrete mixtures. Concrete specifications, embodying the above requirements, may be expressed as follows:

The aggregate shall be clean, hard and durable. The largest particles shall be as large as the type of structure will permit. The proportion of fine to coarse aggregate shall be such that the density of the total aggregate shall be a maximum and sufficient cement, and water in a predetermined ratio depending upon the quality of cement and the strength of concrete desired shall be added to produce a mixture of proper flowability consistent with the nature of the work.

The method of procedure, therefore, in determining concrete mixtures is as follows:

(1) Select an aggregate the size of the largest particle being as large as the work will permit.

(2) Determine the ratio of fine to coarse aggregate which will produce the greatest density.

(3) Add cement and water in a predetermined ratio, dependent upon the strength desired, to the aggregate to produce a mixture of such plasticity as is most suitable for proper depositing in the work.

An economical mixture is one in which a minimum amount of cement is used and, since the ratio of water to concrete is definite for a given strength, the drier the concrete, the less cement is required.

In a given volume of concrete, the greater the volume of aggregate the smaller the amount of cement and water will it contain.

It follows then that the most economical concrete of a given quality is that in which the aggregate is graded to a maximum density and mixed as dry as is consistent with the field requirements.

A simple method of determining the economical proportions to meet the above requirements is given below. This method has been tried out and has yielded results which warrant its recommendation by the committee.

Having selected clean, hard and durable aggregates, combine varying proportions of the dry, fine and coarse until a proportion is reached, which gives the densest mixture, i. e., that which weighs most per unit of volume.

To this densest mixture add varying amounts of a cement paste (cement and water), premixed in the ratio corresponding to the strength required, until the desired plasticity is obtained.

From the weight of a unit volume of the concrete thus obtained and the weights of the ingredients it contains, derive the proportions and material factors.

The determination requires a very nominal equipment and may be conducted in the field in a very short time, thereby making it possible to make such corrections in the proportions as may be necessary due to changes in the characteristics of the materials or working conditions, thereby maintaining the quality of the concrete uniform and the cost as low as possible.

A manual for the determination of proportions by the maximum density of aggregate and cement paste method is included in the committee report, accompanied by a graph of tests made, showing the variation in density of damp sand measured loosely and of the same sand measured in a submerged condition or inundated.

In the discussion following Mr. Bertin's progress report, Prof. A. N. Talbot expressed the opinion that the most dense aggregate is not that which makes the most dense concrete. More study by the committee was recommended along this line.

Expansion Joints

A preprinted report of Committee E-8 on expansion joints in concrete construction was submitted as a basis for further discussion. The material was submitted by the committee, not as a complete report, but merely as a series of suggestions to put before the Institute membership in the hope that from it would result some discussion, suggestions and particular information based on the experience of the individual designers and constructors in the Institute. The committee has in mind for the continuation of the work a brief summary of existing structures and behavior of expansion joints, so far as they can be compiled, and expressed a desire for any further data along that line.

Serious Concrete Failures and Their Causes and Remedies

Reports on the work of Committee E-6 were presented by John A. Ferguson and P. J. Freeman, two members of the committee,

as to the progress of the work this year. Mr. Ferguson read a paper, illustrated by lantern slides, showing cases of disintegration that have been investigated. One important conclusion drawn was that the SO_3 content in gravel aggregate from rivers in certain sections of the country affects the concrete wherever seepage occurs. The committee will continue its study outlined in the progress report.

Waterproofing Concrete

In submitting the report of Committee E-7 on waterproofing, S. C. Hollister stated that the committee solicits any data on any waterproofing compound available. Tentative standards are to be prepared by the committee for next year. The committee's report reviews the 1922 report to the Institute outlining the basis upon which the work of the committee would be conducted.

The classification of the materials used as penetrative surface treatments given in the committee's last year's report has been amplified as follows:

(1) Water solutions of inorganic salts which are supposed to react chemically with constituents in the concrete. (a) Magnesium, zinc, lead and aluminum fluosilicates. (b) Sodium silicate (water glass). (c) Zinc, iron and aluminum sulfates and alum. (d) Barium and calcium chloride.

(2) Water suspension of substances or mixtures of substances of a pore-filling character or which react chemically with each other or with constituents in the concrete and are supposed to form pore-filling compounds. (a) Iron filings and ammonium chloride (sal ammoniac). (b) Casein. (c) Fuel oil and soap.

(3) Soaps. (a) Water solutions of alkali soaps. (b) Solutions of metallic soaps in volatile solvents.

(4) Combinations of solutions in two or more applications, which are supposed to react chemically with each other in the pores of the concrete, filling them with substances of a water repellent or insoluble character. (a) Soap solutions and inorganic salts. (b) Inorganic salt solutions. (c) Sodium silicate and acid solutions.

5. Solutions of liquid and solid hydrocarbons.

6. Waxes, fats and solid hydrocarbons applied hot.

The work of the sub-committee on waterproofing concrete is being limited to producing waterproof concrete by a combination of portland cement and water with fine and coarse aggregates. Concrete in which there is a material other than portland cement and the material ordinarily used as fine and coarse aggregate will not be included in the work of the committee.

Other sub-committees are working on integral methods and plaster coatings; bituminous coatings and membrane systems; non-bituminous surface coatings. The non bituminous coatings include: (1) Cellulose compounds; (2) Drying and semi-drying oils; (3) Admixtures, with the drying and semi-drying oils of other materials for special qualities; (4) Pigment admixtures with the above, generally called paints; (5) Solid materials which require heating for application; (6) Solid materials thrown into solution by solvents of various kinds; (7) Metalizing processes.

Bending Moments in Columns

Bending moments in columns was discussed in a paper by F. E. Richert, of the University of Illinois, the object of the paper being to show the amount and distribution of moments in building columns under certain conditions, as indicated by analysis and by the results of experiments, as well as to make a study of the resistance of columns subjected to both bending and axial stresses. The reinforced concrete building is referred to as a highly indeterminate structure subject at best only to approximate analysis, but, due to the numerous laboratory tests and to investigations of full-sized structures that have been made, the opinion is expressed that there is probably more information now available on the action of the reinforced concrete structure, as a whole and of its elementary parts, than there is on any other type of construction.

Four general ways in which bending moments are induced in the columns of buildings are cited as (a) by reactions from eccentrically placed beams or from brackets or cantilevers; (b) by an eccentricity of the column itself, such as occurs at changes in section of wall columns in which the exterior face is kept vertical throughout its height; (c) by the action of wind pressure, which must be resisted through the stiffness of connections between the columns and girders or slabs; and (d) by transfer from slab or girder of unbalanced moment produced by floor loads. It is noted that of these four cases the first two are generally statically determinate, since the amount of load and the eccentricity are known. The calculation of wind stresses in reinforced concrete buildings is unusual, except in very high, narrow buildings. The problem of determining the bending moment due to unbalanced load is considered the most difficult of the four mentioned. The results by the solution used in the paper are given not as exact solutions of the building frame, but as such as should serve to indicate the magnitude and distribution of the moments that exist.

The paper is subdivided under the following headings: Methods of analysis; Exterior or wall columns; Interior columns; Moments in flat slab construction; Moments of inertia; Loading producing maximum stress in columns; Tests on moment distribution in columns; and Resistance of columns to combined stress. It is concluded by the following summary:

In review, it may be stated that while bending moments are not commonly considered in the design of reinforced concrete columns, it is known that such moments exist and frequently cause stresses of considerable importance. Provision for such stresses which are practically certain to occur with ordinary conditions of loading seems logical and proper. At the same time it seems justifiable to use higher working stresses for the condition of an extreme fiber stress than for the condition of a uniformly distributed stress which has no possibility of a favorable redistribution over the cross-section.

The values of column moments given in this paper are not the result of freakish or improbable loadings. There are many other possible arrangements of load that will produce moments nearly as great as the ones given. It is felt that the moments shown may be taken as a basis for the design of structures of ordinary proportions. For other types of structures the methods used here should prove useful in analyzing the effect of the particular conditions encountered.

Reinforced Concrete Building Designs

The report of Committee E-1 outlined the five divisions into which the committee is divided, and a progress report was made, reviewing briefly the work accomplished by each division.

Division No. 1 is charged with the work of revising American Concrete Institute standard specifications for building regulations for the use of reinforced concrete. Division No. 2 is to supply new

information where deficiencies in previous reports have existed. This includes three main subjects: the design of temperature reinforcement, design of two-way slab on beams, and design of lintel beams (torsion). The program for Division No. 3 calls for the work of assisting municipalities who are revising their building codes, by affording them the services the committee is able to render. Division No. 4 is cooperating with other agencies, which cover or touch upon the field of activity in which the committee is interested. Division No. 5 is collecting information as to what is currently in actual use in the field, and with studying accidents, fires, etc., to learn the lessons they teach.

A special bulletin is to be issued later in the year by the committee reporting on "Proposed Design Treatment for Two-Way Slabs."

Fire Resistance of Concrete Block

A good deal of satisfaction comes to producers of concrete building units from the report of Committee P-5, Fire Resistance of Concrete Building Units, of the American Concrete Institute, but not quite enough satisfaction. It is probable that, with the energy and growth which the concrete building unit industry is displaying, further tests will be made.

Through the Institute committee the producers set out to remove what they regarded as discrimination of underwriters against concrete block in their rate schedules.

Producers of competing units have been satisfied to sit tight and rest their case on tradition rather than on underwriter tests, and there are no tests entirely comparable to the tests made on concrete block. A known weakness is in web-cracking, and the tests made do not show to just what extent the load-bearing value of the wall is impaired by web-cracking, nor do the tests give us any direct comparison on this score with certain competing units which have performed less creditably than concrete in instances of actual fires where the two materials come into comparison.

The concrete tests cost about \$6000—\$500 paid by the Institute, about \$250 by Institute member subscriptions; about \$2750 by concrete products manufacturers through the Concrete Products Assn.; and the remainder by the Portland Cement Assn. Following are conclusions from the recent report of Committee P-5:

CONCLUSION

The results of the tests are highly encouraging for they have shown that the fire resistance of the standard concrete block tested is far greater than had been supposed.

The test program was not completed until December 28, and the results are still being studied by the Underwriters Laboratories—who will shortly issue a report on them to their Council.

Prior to the publication of this report it would be premature to make a final report on the proper fire resistance ratings of hollow concrete block as in comparison with other building materials.

The following conclusions, however, may be drawn at this time from the results of the tests:

1. Walls of moderate lengths, properly constructed with regard to piers and buttresses of well-made, 8-in. concrete block can be relied upon to resist the passage of flame in fires of ordinary intensity for a period exceeding five hours without spalling or cracking of the surface—and if exposed to fire hose stream during that period will not collapse. The impact of falling beams is not likely to overturn the wall.

2. A temperature of 300°F on the unexposed face of block in an 8-in. wall may be expected at periods ranging from two hours and thirty minutes to three hours and thirty minutes, according to the form of the block and the aggregate used.

3. The bond between portland cement stucco and concrete block is sufficient to cause the stucco to adhere when exposed to furnace temperatures and can be relied upon to delay reaching the 300° point for one hour and also protect the block in large measure from

the splitting or cracking observed in some panels of the unstuccoed block.

4. The exposure to flame for three hours or more causes a deterioration of the exposed face and loss of strength in the block up to as much as 30 or 40% when not covered with stucco. But the fire tested block regain a good deal of their strength after the fire and in no case does the strength of the unit go below the usual allowable loading of city building codes.

5. Web cracking may be expected in a large proportion of hollow concrete building units exposed to fire. This cracking occurs early in the fire, usually before 30 min. has elapsed.

The question remains unanswered as to whether the structural stability of the wall has become seriously impaired when web cracking has occurred. Although this point is very important it cannot be regarded as a critical one as long as there is no comparative data in the recent fire tests in brick walls points out that compression on brick and clay tile walls. The report of the Bureau of Standards tests made of masonry before and after fire tests, while indicating adequate strength for most of the brick, indicated in some cases such loss of strength in the fire test, that, taken in connection with the deflections obtaining at the end of the test, might prejudice ability to carry working load.

Tests made on block taken out of the panel after the fire test show a loss of strength varying between 25 and 40% so that it might be reasonable to assume that block carrying one 1000 lbs. per sq. in. on the gross area before the test would be good for at least 600 lb. per sq. in. afterwards. Concrete block walls are practically never used for heavy loads. Building codes usually allow a maximum load of 70 to 100 lb. per sq. in. on concrete block walls. The practice almost universally adopted is to use a structural frame when heavy loads are to be carried. In residences the load on the wall very seldom exceeds 40 lb. per sq. in. In buildings of this class there should be, therefore, an ample factor of safety even after a severe fire if there is not more than 50% of cracked block.

The remarkable recovery in the strength of block after removal from the fire (especially on those block which are first subjected to an absorption test) would indicate that there is no concealed fracture in any of the block, as even a recovery in strength of the concrete itself would not result in an equal recovery in the strength of the block if there was concealed internal cracking.

The effect of this web cracking upon the ability of the wall to safely bear its load during or after the fire exposure period is dependent upon several variables including the height of the wall, the live load which it carries, and whether or not this load is uniformly or eccentrically applied with respect to the wall thickness.

The importance of web cracking in its influence on the load bearing qualities of the wall could not be determined with the Laboratories facilities at our disposal, and it is very desirable that further investigations be made on this point. There can be no doubt that when a large percentage of blocks are cracked, the strength of the wall is thereby reduced, but we could not determine whether the strength had been reduced to a point where the factor of safety had been encroached upon.

Building codes usually call for a load not exceeding 100 lb. per sq. in. on walls of concrete block. The Standards of the American Concrete Institute for medium load bearing walls call for block 750 lb. per sq. in., and as far as pure resistance to compression is concerned the walls have such a large factor of safety that even if the whole load were carried after a fire on the inner half of the block, a wall in a normal building loaded up to the limit allowed by the code would have strength enough to carry the load; and inasmuch as the walls showed no serious face cracking or sign of disintegration and were uninjured by the falling beam except for the hole cut at the point of impact, it would seem that concrete block walls were amply strong for the purpose for which they are commonly used.

Consideration of stability of wall for use in rebuilding seems to

us to be of similar moment, but we think it may be fairly argued that this assembly must be at least as stable as brick or clay tile walls.

Take, for instance, the common brick wall laid in lime mortar. Even if such a wall remains uncracked the intense heat of a severe fire would dehydrate the mortar entirely¹ and you have as a result a wall consisting of brick resting in a bed of material having little more strength than sand. If the wall is laid in portland cement mortar it may be a little stronger but it is obvious that the customary methods of laying a brick wall in cement mortar could not result in producing such a strong mortar as the mortar or concrete in the ordinary concrete block. Moreover, brick are not usually true to shape, their irregularities being taken up by the mortar. The concrete block is true and square and is laid with a much thinner joint; and therefore, assuming that the mortar in a wall laid in cement mortar and a wall of concrete block are affected to the same degree, the strength of the concrete wall must obviously be greater after a fire than that of the brick wall laid in cement mortar.

Clay tile has not only the disadvantage of irregularity in shape and thick mortar joints above referred to, but it is also subject to cracking of the webs. Clay tile also are ordinarily laid in lime mortar while concrete block are laid in cement or lime-cement mortar.

6. The method of manufacture and curing, which had a marked bearing on the compressive strength of the block had practically no effect on its fire resistance. In this connection it is interesting to notice that block in Panel B, which had the highest strength in compression, had a higher percentage of cracking under fire than Panel A. Panel D, in which the quality of concrete was the highest, had nearly every block cracked during the test; however, these units had very thin shells.

7. Although there was a slight variation in the performance of

¹Bureau of Standards Report of Fire Tests on Brick Walls states, "There was loss in strength of lime mortar approaching disintegration which must be considered where masonry strength is concerned."

blocks of different form made on different machines, it may be stated that for practical purposes as regards one-piece hollow units, the form of the block had very little effect on its fire resistance.

8. The kind of aggregates used had practically no bearing on its fire resistance except in the case of coarse aggregate of highly siliceous material, which seemed to be less fire resistant than other material.

No detail analysis was made of the gravels to determine the composition of finer particles as distinct from coarse particles. It is generally found the so-called calcareous aggregates have a fairly high percentage of siliceous material and in such cases the finer material is usually siliceous, while the larger pebbles are calcareous. It is noticeable that all of the fine aggregates used had a high percentage of siliceous material. (See tests on aggregate samples 6416 and 6417).

It is, therefore, the expectation of the committee that 8-in. concrete block walls of good quality block not containing highly siliceous aggregate and passing the A. C. I. tentative standards Class B will be recognized in Underwriters' Laboratories' report as a satisfactory fire resistant in panel enclosures, and other non-load bearing walls and also in lightly loaded walls.

When block are protected from direct contact with fire by brick veneer, portland cement stucco, or plaster, their fire resistance is considerably increased and they can then be recommended for heavier load bearing.

The tests have all been made on 8-in. walls of hollow concrete block and in order to complete a study of this subject it is highly desirable that a further program of tests should be laid out to include:

- (a) 12-in. walls of hollow block
- (b) 8-in. walls of 2-piece block

In the light of the tests already made it is probable that each of these constructions will show higher fire resistance than those tested in present series.

It is also essential that further tests be made on 8-in. walls under load in order to determine what effect the web cracking has on the stability and load bearing qualities of the walls.

Economical Products Manufacturing Processes

From Advance Report of Copyrighted *Proceedings*, American Concrete Institute, as presented in convention, Chicago, Feb. 25 to 28, 1924.

The economical production of concrete products of uniform quality is a subject to which little attention has been directed by manufacturers or investigators. Exhaustive research work has definitely established the laws governing the more important properties of plastic concrete mixtures such as are generally used for monolithic concrete structures and concrete products of the so-called "wet cast" type. However, little is known regarding the application of these laws to the drier concrete mixtures used for tamped machine made products. For the purpose of obtaining more information upon the factors which govern the strength and other properties of the relatively dry concrete mixtures, members of Committee P-6, Concrete Products Plant Operation, J. W. Lowell, chairman, of the American Concrete Institute, have carried out considerable experimental work in products plants.

The results of these investigations show that in general the fundamental laws governing the properties of plastic concrete mixtures may be applied to the drier concrete mixtures used in the commercial manufacture of concrete products.

It is the purpose of this report to point out how these fundamental principles may be applied to the manufacture of concrete products, so as to reduce production costs.

A study of laboratory and field tests shows that the principal factors controlling the quality of concrete are:

- (1) *Aggregate.*
- (2) *Quantity of Cement.*
- (3) *Quantity of Mixing Water.*
- (4) *Time of Mixing.*
- (5) *Curing-age.*

AGGREGATE

Products manufacturers as a rule do not know what constitutes a good aggregate, and are therefore unable to judge the relative value of the various available aggregates.

For maximum strength and durability the aggregate must be clean. It should be free from organic impurities and should not contain more than 10% silt by volume. To secure a given strength more cement is required with poor aggregate than with good aggregate.

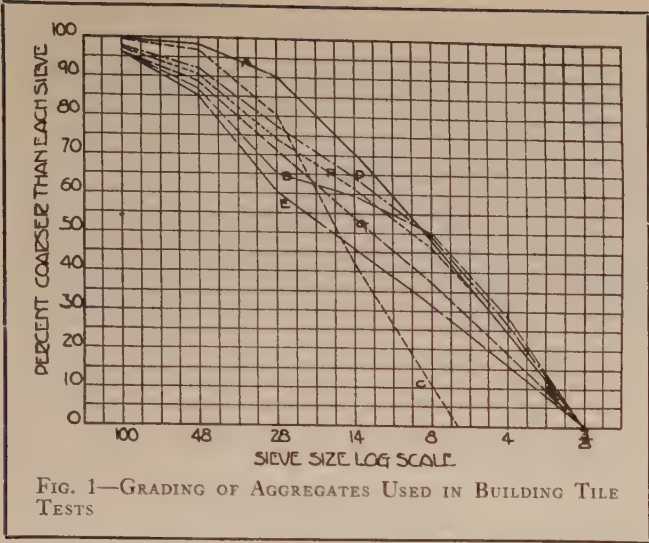
Other conditions being equal that aggregate having the greatest percentage of coarse particles will make the strongest concrete provided it can be satisfactorily handled by the machine. The fine aggregate commonly used produces a smooth appearing product at the sacrifice of strength. Such aggregate should be corrected by the addition of coarser particles. Coarsely graded aggregates result in products of rough texture. Where objection to rough textured products exists, manufacturers should make a special effort to overcome this objection by educating their customers to appreciate the economies which result through the use of coarsely graded aggregate. In certain types of units having thin walls, such as tile, it is however essential that the aggregate have a sufficient amount of the fine particles to compact the concrete in the thin walls and to prevent the product from cracking or crumbling upon removal from the machine.

In a series of tests on building tile made at Cincinnati using a 1:4 mix gradings B, E, F and G in Fig. 1 gave mixtures best adapted to the type of machine used and produced tile of high strength; grading A, C and D gave harsh-working unsatisfactory mixtures resulting in tile of rough appearance or relatively low strength. It is recommended that products manufacturers try out several gradings of aggregate to determine the coarsest grading it is possible for them to use with their particular machine.

The grading of an aggregate is determined by sieve analysis. A convenient measure of the grading of an aggregate is given by the fineness modulus¹. The fineness modulus is the sum of the percentage of particles coarser than each sieve in the sieve analysis when the following sieves are used: 100-48-28-14-8-4- $\frac{3}{8}$ - $\frac{3}{4}$.

Fine drift or beach sand graded to the No. 28 sieve has a fineness modulus of approximately 1.50. Medium sand graded up to the No. 8 sieve has a fineness modulus of approximately 2.50. Coarse and graded to the No. 4 sieve has a fineness modulus of from 3.00 to 3.25. Roofing gravel graded from No. 4 to $\frac{3}{8}$ has a fineness modulus of approximately 5.50. Pebbles graded from No. 4 to $\frac{3}{4}$ have a fineness

¹Refer to Circular 1—Structural Materials Research Laboratory, Vol. 19. American Society for Testing Materials Proceedings.



modulus of approximately 6.25. Fine and coarse aggregates may be proportioned to give any desired grading.

The effect of grading of aggregate, as measured by fineness modulus, on the strength of concrete tile and on concrete brick is shown in Figs. 2 and 3. It will be noted that as larger sized aggregates were used up to a certain coarseness there was a marked increase in strength for all mixes.

Fig. 2 shows that the same strength was obtained with 1:5 mix using aggregates having a fineness modulus of 4.25 as was obtained with a 1:3 mix for a fineness modulus of 2.8. Similarly in Fig. 3 the same strength was obtained in a 1:9 mix having a fineness modulus of 4.25 as was obtained for the 1:5 mix with fineness modulus 2.75. This demonstrates the saving in cement which may be effected through the use of the larger sized aggregates. This saving may amount to as much as .02¢ for each 8x8x16-in. block. In a plant producing

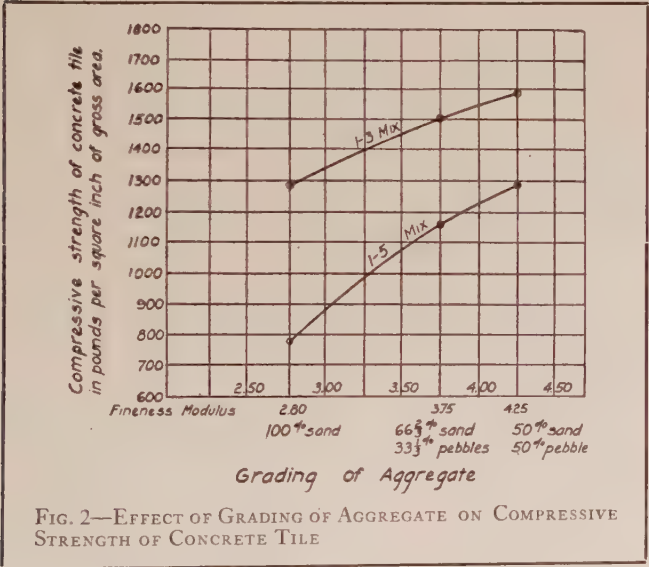


FIG. 2—EFFECT OF GRADING OF AGGREGATE ON COMPRESSIVE STRENGTH OF CONCRETE TILE

300,000 blocks per year, this means \$6,000 per year; the interest on \$100,000 at 6%. Such a saving will easily justify the purchase of better-graded aggregate and the equipment necessary for handling it.

QUANTITY OF CEMENT

Figs. 2 and 3 show that for the same grading of aggregate substantial increase in strength can be obtained with increase in richness of the mix. The results of these and other tests indicate that for each 1 % of cement that is added there is an increase in strength of approximately 1% for the mixtures ordinarily used in the manufacture of concrete products. This will enable the manufacturer to adjust proportions to obtain the required strength and also to judge of the relative economy of available aggregates.

AMOUNT OF MIXING WATER

Tests show that the strength of concrete is influenced to a marked degree by the amount of mixing water used. Either too much or too

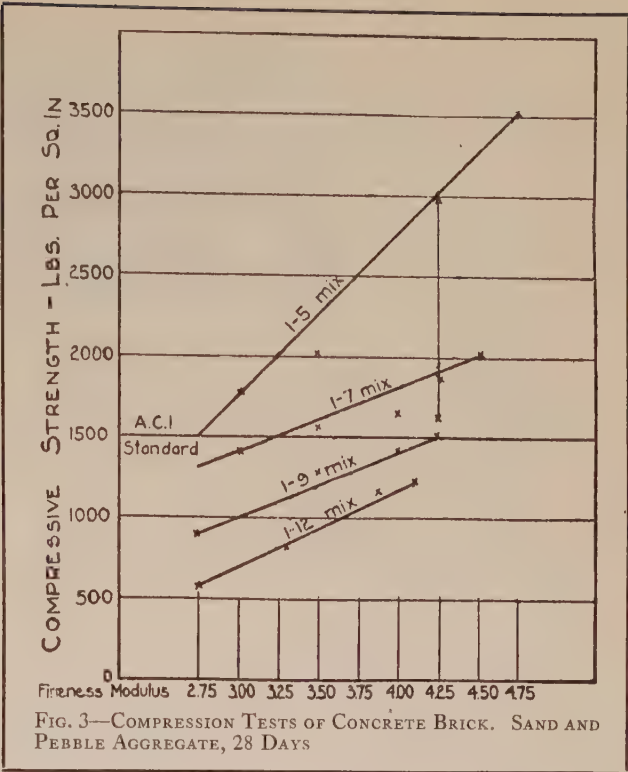


FIG. 3—COMPRESSION TESTS OF CONCRETE BRICK. SAND AND PEBBLE AGGREGATE, 28 DAYS

little water will decrease the strength materially. For wet-cast products the highest strength is obtained when the amount of mixing water used is reduced to the smallest quantity that will provide a workable mix. For tamped machine made products the highest strength is obtained when the amount of mixing water used is increased to the largest quantity that will provide a workable mix. Workability may be determined by compacting a ball of concrete with the hands for about 1/2 minute. Concrete of the proper workability for a tamped product will show a thin film of moisture on the surface of the ball after this treatment. Another indication of the proper workability for this product is the appearance of water marks on the stripped surfaces. The effect of amount of mixing water on the strength and absorption of tamped machine made block is shown by the data in the following table:

TABLE I				
Mix 1:5 by volume, aggregate being sand and pebbles.				
Consistency	Water lb. per Sack of Cement	Compressive Strength, lb. per sq. in.		Absorption Per Cent Gain in Weight after 24 Hours
		Gross Area	Net Area	
Wet.....	59	1125	1908	5.5
Damp.....	51	1025	1732	5.6
Dry.....	43	917	1550	6.8

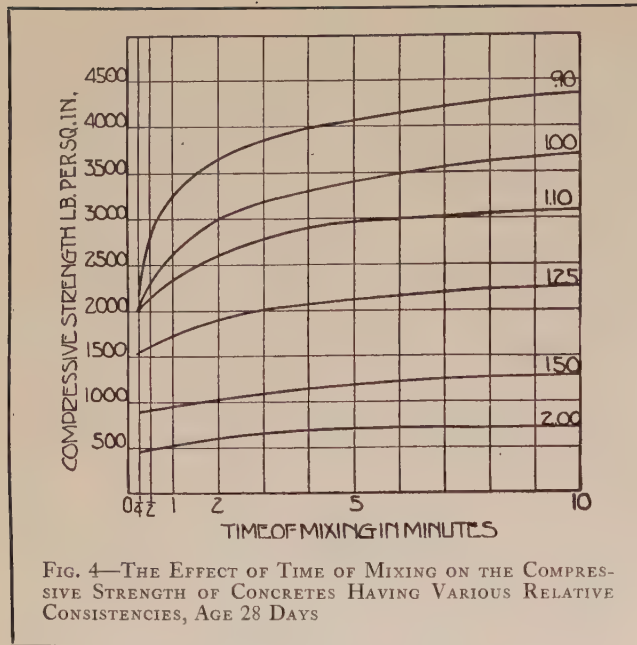
The above "wet" consistency produced a product with a distinct water web and fulfilled the conditions already described for a workable concrete. It will be noted that this consistency gave the highest strength and lowest absorption.

MIXING

To secure maximum uniform strength of the concrete the materials must be thoroughly mixed. Results of tests made at the Structural Materials Research Laboratory, Lewis Institute (*Proceedings*, A. C. I., 1918) show that increase in time of mixing materially increases the strength and uniformity of the concrete. Fig 4 shows the relation between the time of mixing and the compressive strength at 28 days for relative consistencies ranging from 0.9 to 2.00. The driest concrete used in these tests (Relative Consistency 0.90) is about the same as that which may be employed for tamped machine-made products. For wet-cast products a consistency of about 1.10 would ordinarily be required. The curves show that substantial increases in strength are obtained from increased time of mixing and that greatest increases are obtained for the drier consistencies. This shows that more benefit is gained by increasing the mixing time of drier mixes. Table No. 2 gives the percentage increase in strength at 28 days obtained for concrete of relative consistency .90 and 1.10. As stated previously these consistencies approach those best suited for dry tamp and wet-cast process respectively. It is evident from these data that it is desirable to mix at least 2 minutes and longer if conditions will permit. Increasing the speed of the mixer does not have much effect on the strength of concrete. Consequently nothing will be gained by speeding up the mixer in an effort to increase its production.

*Refer to Bulletin 1—Structural Materials Research Laboratory.

Ohio Concrete Products Association Convention



CURING

The maximum advantages from the control of aggregates, quantity of cement, quantity of mixing water and time of mixing can only be secured when the curing conditions are also controlled. Tests show that the full strength of the cement is only developed when concrete hardens in a warm moist atmosphere. Under such curing conditions the strength at 28 days will be practically the same for temperatures of from approximately 65 to 212° F. But the strength of the concrete at from 1 to 7 days is materially increased by hardening at the higher temperatures.

As the manufacturer should endeavor to produce products that will always pass definite requirements, but with a uniformity minimum margin, he must know that the curing conditions are practically the same at every season of the year.

TABLE II.—EFFECT OF TIME OF MIXING
Percentages of strength of concrete mixed 2 minutes:
Consistency 0.9 for tamped concrete.
Consistency 1.10 for wet-cast concrete.

Relative Consistency	Time of Mixing, minutes							
	1/4	1/2	1	2	3	4	5	10
0.90	58.8	75.5	89.4	100.0	105.4	109.1	111.2	120.0
1.10	78.5	82.6	89.4	100.0	107.7	112.5	114.5	119.3

TABLE III.—EFFECT OF TEMPERATURE ON THE CURING OF CONCRETE
Percentages of strength at 28 days curing at 65° F.

Length of Curing, days	Temperature, Degrees Fahrenheit			
	65	95	125	212
1	12	22	35	44
2	21	35	49	59
3	32	44	60	68
7	56	68	79	85
28	100	103	109	103

Above is based on curing in saturated atmosphere.

The manufacturer who finds it necessary to deliver products at less than 28 days after they are manufactured can be guided by table No. 3 which shows the strength of products hardened at various temperatures in saturated air as percentages of the strength of products hardened in saturated air at 65° F. for 28 days.

CONCLUSION

The recommendations in this report are emphasized because the time is not far distant when the manufacturer must take advantage of every production economy in order to survive the keen competition of the more progressive concrete products manufacturers and producers of other building materials.

The Committee wishes to express its appreciation of the cooperation of the following organizations that took part in the investigations referred to in this report:

- Portland Cement Association
- Structural Materials Research Laboratory
- Universal Portland Cement Co.
- Marquette University, Milwaukee, Wis.
- Drexel Institute, Philadelphia, Pa.
- Prairie Concrete Products Co., Prairie du Chien, Wis.
- Wm. H. Devos, Milwaukee, Wis.
- South Philadelphia Builders Supply Co., Philadelphia, Pa.
- Hilker Supply Co., Granite City, Ill.
- Stainfield & Nichols Co., Joliet, Ill.

The Third Annual Convention of the Ohio Concrete Products Association, January 8 and 9, 1924, at the Deshler Hotel, Columbus, Ohio, showed an awakened interest of the products manufacturers in the necessity for quality products in increasing their business. The Pittsburgh district office of the Portland Cement Association has been very active in bringing this condition about. Manufacturers present at the meeting represented more than 80% of the total concrete block production of the State of Ohio. E. W. Dienhart, of the Products Bureau of the Portland Cement Association, explained modern scientific methods for obtaining quality concrete products.

The practical demonstration of concrete block manufactured by Pete Nelson, Spencer, Iowa, was a feature in itself well worth the time and expense of any concrete products manufacturer at the convention. Mr. Nelson, one of the large concrete block manufacturers of the country, as well as one of the strongest believers in quality concrete products, demonstrated in a practical way what Mr. Dienhart explained.

Herbert Briggs, state architect, and chairman of the Ohio State Board of Building Standards, explained the necessity for a revision of the Ohio State Building Code by stating that the present code was adopted by the Legislature following the Collinwood School fire and several other disasters, with the loss of many lives in Ohio. The reaction resulted in a very drastic code, making building operations unnecessarily expensive. He told of the operation of the new law passed in 1923 by the Legislature creating the Board of Building Standards, whose duty it is to recommend needed amendments to the present law as well as new laws to the next Legislature, to declare by rule that an approved material, device or method of construction is an equivalent to a material, device or method of construction now approved by existing law. Mr. Briggs stated that for concrete building units to get the recognition justly due, they must be of uniformly high quality.

Officers were reelected as follows: President, S. J. Crew, Cincinnati, O.; Vice President, F. A. Owens; Akron, O.; Secretary-Treasurer, George M. Friel, Columbus, O.

Nineteen district chairmen from among the products manufacturers of the state were appointed to work for new members to the state association, and cooperate with the manufacturers in their district for quality products.

Marion F. Stout, of Covington, Kentucky, a member of the Ohio Concrete Products Association, started something by throwing \$10.00 on the table as a little contribution to the good cause of the Ohio Concrete Products Association. This grew in 30 minutes in pledges and cash donations to more than \$1,100. The following day the sum was increased to \$1,625. Needless to say such a burst of enthusiasm was very gratifying to those who have made an honest effort to make this association a real live service organization.

A petition of the Ohio Concrete Products Association to the Board of Building Standards asking for the recognition of concrete building units as a fire-safe construction and placing these units on a parity with other building units, was read and approved by the members.

The next convention will be held at Cleveland, Ohio, January 13 and 14, 1925.



PLANT OF GULF
CONCRETE PIPE
CO. AND LOADING
MACHINE

A Start From a Defeat in Pipe Business

BY GRADY TRIPLETT

It took a whipping, and what N. A. Eppes terms a "good one," to put him in the concrete pipe business. He is president of the Gulf Concrete Pipe Co., Inc., Houston, Texas. In the last two years his company has furnished 122 miles of drain and sewer pipe for the city of Houston—the total output of the plant. Plans are now being worked out to provide increased output.

The whipping which put the Houston man in the concrete business was not of the physical order. But it hurt even worse, he admits, when back in 1918 he set out as the representative of clay pipe producers to prevent the concrete people from getting a contract in Globe, Ariz.

All his 10 years of clay pipe experience went for nothing when one of the concrete pipe makers got down to essentials with the buyers. At first he took it to heart and became sullen. Slowly he began to realize that he had been beaten on product only.

And that was the basis for the decision to get into the concrete pipe business. He set up a small plant out on the Harrisburg boulevard to complete a contract for sewer pipe for Magnolia Park, an incorporated suburb adjoining Houston. Success of that contract turned him to thinking of other city work.

The market was at his door, for Houston was, in 1921, entering on a big program of expansion. Before he had finished the contract for Magnolia Park, he was hard after the Houston city engineer. The engineer was a willing man, who believed in concrete pipe for sewer construction, but he needed assurance of its stability. What he wanted amounted almost to a guarantee. He had to know that concrete pipe would serve the purpose. Eppes suggested tests of the product which satisfied the engineer.

So the pipe were sold to the city of Houston under these conditions. On each job, one length out of each 200 lengths is taken to the Houston office of the Pittsburgh Testing Laboratories. There it is given a test prescribed by the city. Its acceptance depends on that. The plan has worked to the advantage of both maker and buyer.

In the opinion of Mr. Eppes, the first requirement for putting out in the concrete manufacturing field is a product. He found it in pipe, and he gives his defeat as the representative of clay pipe as the reason for finding his product. He bought the machinery and the process used by the concrete manufacturer, who defeated him, when he set up his plant in Houston.

The next essential is a sure market. The city of Houston proved his best source of outlet. It required

special conditions to get the contract for the city, but that is where salesmanship came to his assistance. He was out to sell, knowing he had a market, provided he could find the means of getting into it.

The present plant has 6,000 sq. ft. of floor space. The gross business of its first fiscal year was in excess of \$100,000, all coming from the treasury of the city of Houston. The payroll that year was \$20,000.

The addition to be built will increase the floor space of the plant to 16,000 sq. ft. The expansion in plant capacity is to be followed by an expansion in sales efforts. While the effort will be made to hold the business of the city of Houston, equal efforts will be made to get contracts from other cities as well as from institutions that may require drain or sewer pipes.

Smaller cities in the Houston territory will be taken into the expanded sales program. A bond issue for sewer construction in Houston will mean the arrival of a representative of the Gulf Concrete Pipe Co., Inc., of Houston, Texas. And the representative likely will be N. A. Eppes, once a clay pipe salesman, who ran into defeat in striving to compete with a concrete pipe maker.

Eppes takes pride in his plant. One of his pets is a crane for loading heavy pipe, a device designed by himself and now being patented. Starting with a Fordson tractor and a Tulsa oil field winch, he designed a 20-ft. crane to lift a load of 1,000 lb. at a 45° angle. This device will load 24-in. concrete pipe four times as fast as six men can place similar pipe on a truck.

Mr. Eppes has just begun the operation of a concrete roofing tile plant on a site near the pipe plant. He is contemplating the addition of a building tile plant.

Exposure Tests on Colorless Waterproofings

Technologic paper No. 248, issued by the U. S. Bureau of Standards under the heading "Exposure Tests on Colorless Waterproofing Materials," by D. W. Kessler, describes the nature of several colorless waterproofing materials, and physical tests on the various treatments to determine their relative effectiveness, durability, etc. This type of materials is applied to the surface of such porous materials as stone, brick, and concrete in order to render them impervious to moisture without materially changing the natural appearance of the surface. A successful treatment of this kind serves certain useful purposes, viz: To seal up the pores of masonry walls which allow dampness to penetrate from the exterior face to the interior of the building; to act as a preservative on old buildings, monuments, etc., which are disintegrating due to frost action; to retard the absorp-

tion of soot, dust, and stains which mar the appearance of structures.

The greater number of the materials experimented with consisted of paraffin, china wood oil, aluminum soap, and resinous materials dissolved in light mineral solvents. These are applied to the surface of the stone like paint. The dissolved matter is carried into the pores of the stone, and as the solvents evaporate, a considerable portion of the solid matter remains in the stone, which tends to fill or seal the pores.

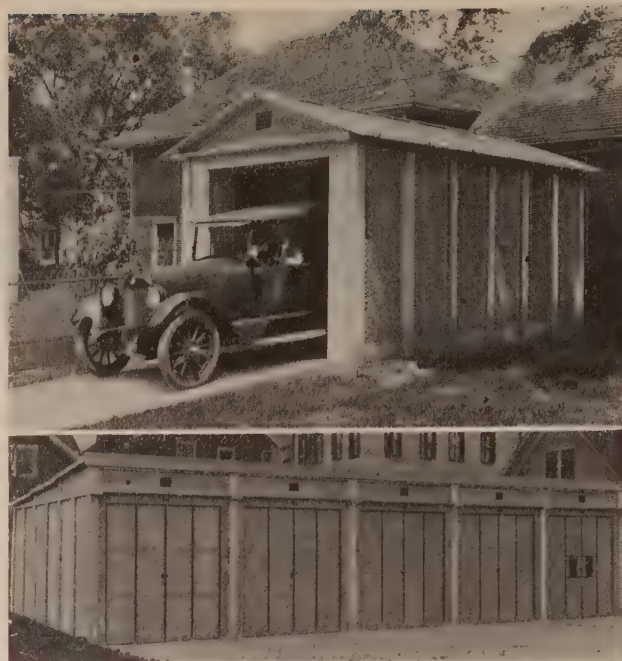
The tests upon which this report is based were made on specimens of limestone and sandstone that were treated on all sides with the waterproofing materials. These specimens were exposed to the weather, and at intervals of a few weeks they were brought into the laboratory and tested for absorption. Some of the treatments proved to be almost worthless from the beginning, others deteriorated rapidly after a few months' exposure, while a few have shown practically no deterioration during two years' exposure.

The conclusions based upon and confined to the materials investigated are as follows:

1. The most effective waterproofing materials in this series are those the waterproofing elements of which are heavy petroleum distillates, fatty oils, or insoluble soaps.
2. The effectiveness of any waterproofing may be greatly influenced by the character of the pores in the stone.
3. Stones having close textures are more difficult to waterproof than those with large pores.
4. The treatments giving the highest waterproofing values and appearing to be most durable are those which use paraffin as the waterproofing element, either alone or in conjunction with other materials. The deterioration or loss of waterproofing value on materials of this type is not appreciable within a period of two years.
5. Waterproofing materials employing resinous substances as the waterproofing element are not durable.
6. Materials consisting of aqueous solutions, the purpose of which is to react chemically with the stone or to act merely as water repellants, have only temporary effects.
7. Separate aqueous solutions, which react chemically with each other and form insoluble substances in the pores of the stone, give low waterproofing values and deteriorate rapidly.
8. In general, those materials which gave the highest waterproofing values produced the greatest discolorations. The amount of this discoloration was proportional to the porosity of the stones. These discolorations decrease on exposure to the weather, and after a year or more, depending upon their intensity, they are compensated for by the fact that the treatments tend to prevent the accumulation of dust and soot on the surface of the stone.

Tests of Nel-Stone Walls

At the request of the Commissioners of the District of Columbia, the Bureau has carried out some tests to determine the compressive strength of walls constructed of Nel-Stone building units, and to determine the suitability of this system of construction for wall purposes. The Nel-Stone system makes use of specially constructed precast mortar blocks 12 in. square, which are laid up without mortar joints or beds. The units are so shaped that when set in place in a wall there are interconnecting, horizontal and vertical passages of circular cross-section throughout the wall. In these passages the reinforcement is placed, and they are then filled with cement mortar of 1:3 proportion. Tests were made on nine walls, 6 ft. long x 9 ft. high with thicknesses of 4, 6 and 8 in. Three experiments were made for each thickness. The average strength of the walls at failure was 700 lb. per sq. in. From the results of these tests it would appear that walls built with Nel-Stone units, and in a manner similar to that used in constructing the test specimens, compare favorably with common brick walls. Where the load carried by the wall is axial and no bending is introduced, any of the walls tested would be safe for a unit working load of 250 lb. per sq. in.



Garages of Precast Units

The pictures show a type of construction with precast units, adapted especially to small garages. The system is patented and controlled by the National Autosafe Co., Kansas City, and is being used by factories in Kansas City and elsewhere.

Precast units employed include wall and roof slabs, pilasters, sills, plates, collar beams, rafters and other necessary pieces. When monolithic concrete foundation and floor have hardened, a precast corner pilaster is set in place, along with a section of the concrete sill. The pilasters and sills are slotted to receive the wall slabs proper, which are 33 in. wide, 8 ft. long and 1 in. thick. When this slab is fitted into place, another pilaster, slotted on two sides, is erected, another section of sill laid, and another wall slab placed. This operation is repeated until the wall is of the desired length. There are special sections of slab made for the windows, the sashes of which are also made of concrete glazed with wire glass.

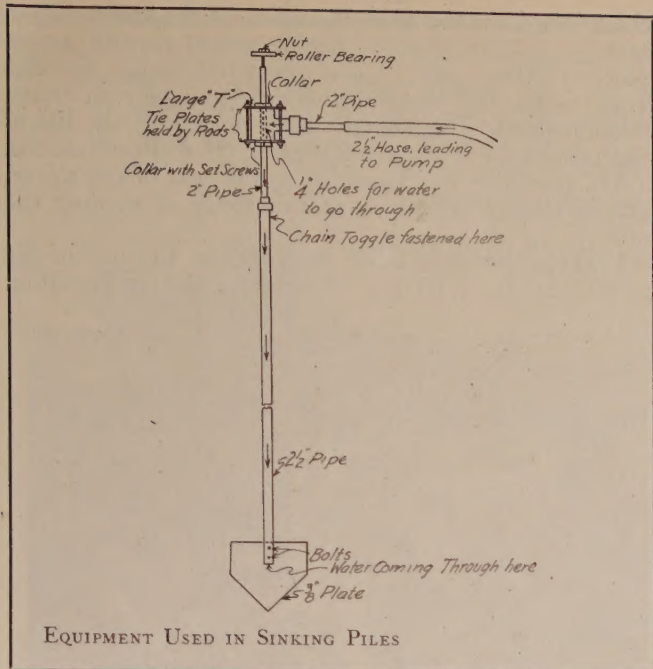
This system is very flexible—a garage can be made any length or width desired. If, later, a new section of garage is wanted, it can be easily supplied.

The roof is also of concrete slab construction, supported by precast rafters 3 ft. apart. The doors are of concrete slabs cast in special steel frames, which are properly provided with hinges so that the sections will fold together.

No mortar is used in the construction. If it is desired to move the building at any time, it can be taken apart as easily as it was put together, and transferred to a new site.

This particular form of garage or store building can be delivered to the site where it is to be erected, in any ordinary motor truck. It is easily portable, reasonable in first cost, is absolutely fire proof, and attractive in appearance. In contrast to most so-called portable buildings, it is thoroughly substantial when erected.

Because the building is entirely of concrete, there is no maintenance expense, and no wood or steel to require periodical painting.



collar, at each end, held by set screws. Packing was placed between the plates and the collar in order that the amount of water escaping should be very small. The upper part of the vertical 2-in. pipe was threaded, and a nut screwed on the end. Underneath the nut a roller bearing was placed, in order to be able to suspend the apparatus from a cable without getting the cable all twisted when turning. The large "T" while held firmly in place, so as to prevent any slipping, did not hold back the turning of the vertical pipes to any appreciable extent.

The scheme worked, and though the process was a rather slow one the piles were placed. The pipes were turned constantly, and a continuous stream of muddy water came down the vertical pipe, flowing out around the plate, which by the way, was a little larger than the diameter of the piles to be placed. A muddy hole was, so to speak, churned into the gravel. Weight had to be applied on top of the pipes to make the outfit go down, but by constant turning a muddy hole was finally made as far down as the piles were to go. When the proper elevation had been reached the "pile hole digger" was pulled out, and the concrete pile driven without any trouble. About three piles on an average could be placed per day using this method.

Unusual Method of Sinking Concrete Piles

By L. J. SVERDRUP

SUPERVISING ENGINEER, MISSOURI STATE HIGHWAY DEPARTMENT

In building the Mt. Sterling River bridge for the Missouri State Highway Department, B. H. Piepmeier, chief engineer, eight, 16-in. octagonal concrete piles 40 ft. long had to be driven their entire length for the foundation approach. When operations were started it was thought it would be an easy matter to sink the piles, thinking that their own weight, and two jets along the sides, would be sufficient to get them down to the required elevation. A trench, approximately 8 ft. deep, was dug, and timbers placed longitudinally and transversely so that each pile would be in its right place, and would be guided as it went down. Two jets, having a pressure of 100 lbs. each, were placed on opposite sides of the pile, and a 6600-lb. steam hammer on top of it. After the first pile had been placed the water was turned on the jets. The pile went down approximately 2 1/2 ft.—and refused to go any farther, even after the steam hammer was put into operation. A fairly coarse deposit of gravel was found at the tip of the piles. This, to some extent accounts for the ineffectiveness of the jets, as the pressure was lost in the gravel.

The piles had to go down, and finally a rather ingenious method was adopted for sinking them. An apparatus as illustrated was rigged up on the job and put into operation. A mud puddle was made, mixing water, mud and clay. One end of a hose, having a guard attached to keep large particles out, was put into the puddle, and the other end was attached to the suction end of a pump. Another hose led from the discharge end of the pump to the 2-in. pipe, as shown on the illustration. A chain toggle was fastened on the 2 1/2-in. pipe as indicated, and the full length of vertical pipe turned in this manner. After the hole became fairly deep two chain toggles had to be used, two men turning on each. The large "T" shown was placed over the 2-in. pipe at a point where 20-1/4 in. holes had been drilled. The "T" was fastened to the 2-in. pipe by means of two plates held together with rods, and a

Lincoln Way Ideal Section to Be Duplicated—Twice as Wide

The Ideal Section of the Lincoln Highway completed recently in Lake County, Indiana, 30 miles south of Chicago, is undoubtedly the finest stretch of the trans-continental road between New York and San Francisco. Oakland County, Mich., is going to provide a road between Pontiac and Detroit which in many respects will be two Lincoln Highway Ideal Sections side by side. It is believed that when the road is completed between Detroit and Pontiac, it will be the finest section of modern rural highway in the United States.

It is interesting to note how this road has developed. About 14 years ago Wayne County laid the first short strip of concrete at one end, now in the city of Detroit, and in 1915 another section was concreted near the Pontiac end. Additional strips of pavement 15 and 16 ft. wide were laid in 1916 and 17, the road being completed to an average width of 16 ft. This new road was not a year old when it became obvious that it was far too narrow to care for the ever increasing traffic.

The state and county now expect to do the job right. A right-of-way of 200 ft. (double the right-of-way secured for the Ideal Section of the Lincoln Highway) has been provided and when the new highway is finished it will consist of two 40-ft. concrete pavements separated by a 44-ft. space in which the interurban line will run. High curbs will separate the interurban tracks from the two automobile highways, each of which will carry one-way traffic. Outside of each 40-ft. pavement will be a "shoulder of gravel 38 ft. wide, for the use of slow moving vehicles and for parking. Thus 78 ft. of width will be provided for travel in each direction.

The Ideal Section of the Lincoln Highway was designed to handle a daily traffic of 20,000 vehicles, estimated to consist of approximately 15,000 passenger cars and 5,000 trucks. On this basis the new Detroit-Pontiac road will, when completed, be capable of carrying in the neighborhood of 40,000 vehicles a day. While it is unlikely that such a traffic will be reached in the near future it will ultimately develop according to those who have the plans in hand.

Extending the Use of Blast Furnace Slag

In an article in *Iron Age* on the utilization of blast furnace slag in the construction field, C. L. McKenzie, of the Duquesne Slag Products Co., suggests future possibilities and how they may be realized. The annual production is about 20 million tons. Of this total the output of the commercial slag plants (all used) is about 7 million tons of which 45% goes for road and street building other than concrete, 25% for railroad ballast, 25% for concrete aggregate, 5% miscellaneous.

It would thus appear that now (or within the near future) the commercial uses for blast furnace slag may consume one-half the production. What the total can become within the next ten years it would be venturesome to predict, but it is certain that it may be increased greatly and rapidly if its promotion and development be given sufficient forceful, carefully planned attention, with strong support from the furnace operators, including active cooperation in maintaining a satisfactory and uniform character of slag.

One direction in which the furnace operators can help to make continually sure of avoiding complaints and objections to the use of slag is by rigidly insisting that ashes, coke dust, flue dust, sand, clay, stone screenings, coal dust and other refuse that accumulates around the furnaces shall be disposed of somewhere else than in the slag pit. Most of the waste materials mentioned are mineral and could cause little actual damage if mixed in with the slag. But they can cause immense damage and interference with the slag business when the inspector will not believe it possible to have good results with these foreign materials in. Especially would the engineer fear bad results.

Engineers also object to the lack of uniformity in the weight of the slag, due chiefly to the varying proportion of the "honeycomb" slag to the dense slag, free of gas pockets. Attention to the lesser operating details, such as the routine method of pouring the slag, and no doubt other small matters that can be discovered by observation—and that do not add real cost—will help to obviate this difficulty, and substantially reduce market resistance to the sale and use of blast furnace slag.

One danger lies in the possibility of changes in furnace practice, particularly in the direction of using a calcite flux exclusively in preference to a dolomitic limestone, or to mixing a small percentage of dolomite with the larger percentage of straight calcite. Furnaces in which the straight calcite stone is used produce a slag that tends to disintegrate on exposure to the air and cooling to the extent of one-third, even one-half or more, of its volume.

Practically it is impossible to use such a slag in a commercial way and it is fit only to be wasted. In granulated form, of course, a slag of this analysis is useful and perhaps for some purposes better than granulated slag from a furnace in which the flux used is dolomitic. But the commercial (or money) value of granulated slag is as yet insignificant even for the purpose for which it is actually used. The iron scrap salvage is also difficult or largely impossible when the slag is granulated. At present the greatest value is recovered from the slag in the hard, air-cooled form and the immediate possibilities of greatly increased use lie in this direction.

Can the operator afford to neglect these possibilities of the use of a substantial percentage of the total slag to be disposed of, by insisting on producing "limey" slag through the use of straight calcite flux? Practically, of course, it comes down to the question of whether the use of a certain percentage of dolomite or a dolomitic limestone really adds to the cost of operating the furnaces and to the corresponding cost of the pig iron. There seems to be a difference of opinion among blast furnace men on this point, but some have changed the flux from calcite to dolomitic limestone for the special purpose of guaranteeing usable slag for construction purposes. Some claim improved furnace operating results and lower cost resulting from mixing a percentage of dolomite with the calcite flux.

Mounted Concrete Mixer Saves Time and Labor for Contractor

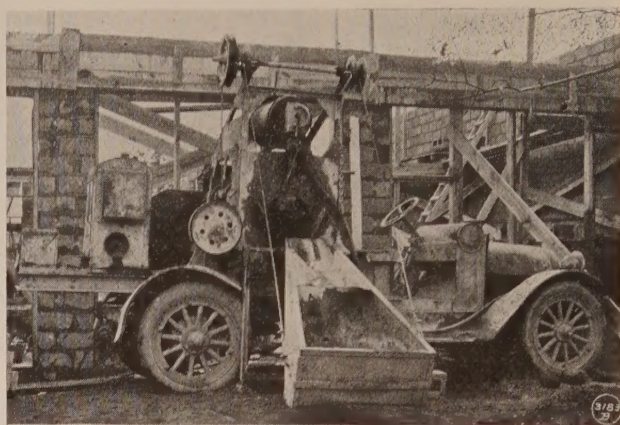
George Leavens, Lansing, Mich., has been able to effect savings of approximately 25% in labor, and even greater amounts in time, by the use of a mounted mixing machine.

Leavens put a 10-ft. mixer, which is one size larger than the average machine used by contractors on light work, on a Reo speed wagon chassis.

His knowledge of gasoline engines warned him that it would be far from economical to attempt to run

the mixer from the 45 h. p. engine of the speed wagon when a 6 h. p. gasoline engine would furnish ample power for the work. Using the truck engine for this work would also have meant wear and tear on transmission parts, which might have decreased the life of the chassis by a couple of years. For these reasons, a 6 h. p. engine was mounted to the rear of the mixer, and is now serving very satisfactorily in turning the mixer.

Leavens saves in labor because, by the use of his mounted mixer, he can eliminate a lot of handling



after the concrete is mixed. For instance, in pouring concrete for a sidewalk, he drives the truck parallel to the sidewalk, pouring as he goes. The same system is employed in pouring outside foundation walls, while, in pouring inside walls, the truck is driven as close as possible to the point at which the work is being done, and much wheeling avoided.

Perhaps the greatest saving in time occurs when one job is finished and the outfit must be moved to another. The jobs are seldom less than a mile apart, and are often two or three times this distance from each other. With the mounted mixer, however, the changes are made quickly.

New Compound Applied to Forms Gives Exposed Aggregate Surface

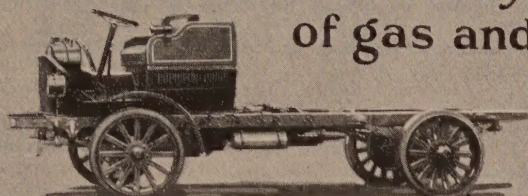
A new method for removing the skin from concrete surfaces to expose the aggregate by using a modified starch compound instead of form grease was demonstrated at the afternoon session of the American Concrete Institute Convention, February 26, by William F. Lockhardt. The liquid composition which is applied as a brush coat to the forms before the concrete is poured is the result of research work and is patented by Nathan C. Johnson of Hool and Johnson, New York consulting engineers.

Forms or boxes were removed from concrete samples during the demonstration and by brushing the exposed concrete surfaces where the compound had been first applied to the forms, the gravel aggregate was easily exposed by removing the skin coat which had been turned to a powder by the action of the compound. Various designs were produced on the samples as a result of the designs having been painted on the forms.

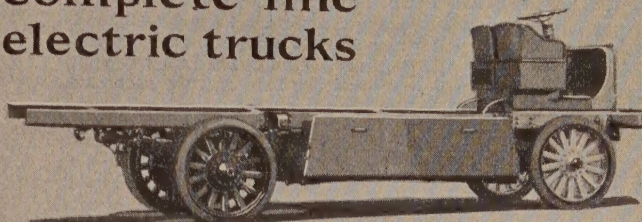
The material which is stated to be a colloidal compound, insoluble in water but soluble in contact with alkaline fluids of concrete, presents a means for eliminating form marks and producing a pleasing surface, and is effective in preventing the appearance of shrinkage cracks or crazing, at a low cost. The cutting or solvent action ceases when the forms are removed from the concrete.

The 1924 Autocar Line

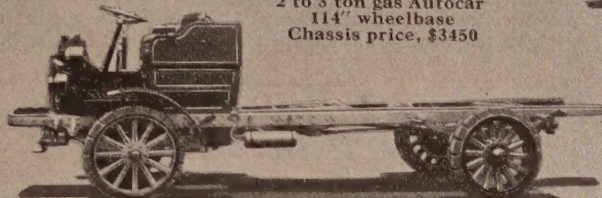
The only complete line
of gas and electric trucks



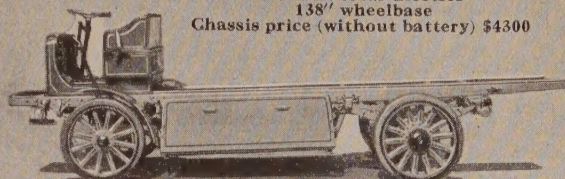
2 to 3 ton gas Autocar
114" wheelbase
Chassis price, \$3450



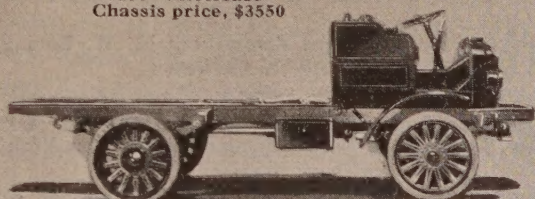
5 ton Autocar Electric
138" wheelbase
Chassis price (without battery), \$4300



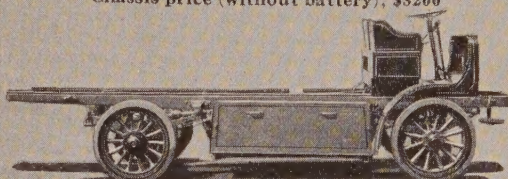
2 to 3 ton gas Autocar
138" wheelbase
Chassis price, \$3550



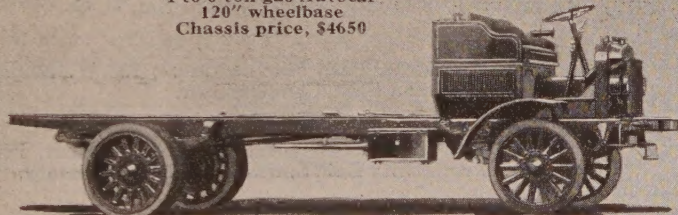
3 ton Autocar Electric
128" wheelbase
Chassis price (without battery), \$3200



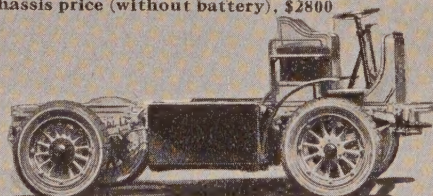
4 to 6 ton gas Autocar
120" wheelbase
Chassis price, \$4650



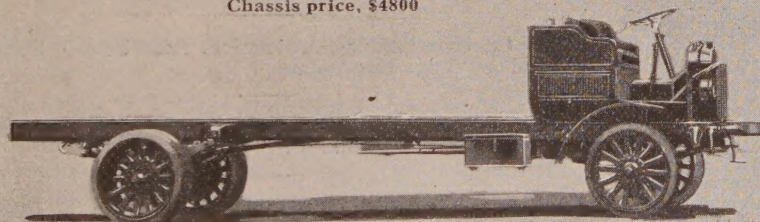
2 ton Autocar Electric
120" wheelbase
Chassis price (without battery), \$2800



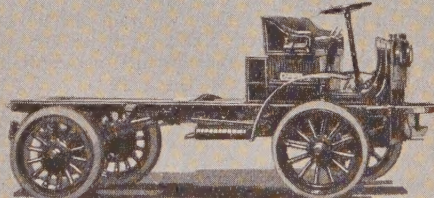
4 to 6 ton gas Autocar
156" wheelbase
Chassis price, \$4800



1 ton Autocar Electric
107" wheelbase
Chassis price (without battery), \$2400



4 to 6 ton gas Autocar
192" wheelbase
Chassis price, \$5200



1 1/2-2 ton gas Autocar
97" wheelbase
Chassis price, \$2200

The Autocar Company, Ardmore, Pa.

ESTABLISHED 1897

Branches in 46 Cities

Autocar

gas and electric trucks

EITHER OR BOTH - AS YOUR WORK REQUIRES

Trade Publications

The Haiss Highway Loader is described in bulletin 124 of the George Haiss Manufacturing Co., Inc., 141st to 142nd Street and Park Avenue, New York. General specifications and illustrations of the equipment at work, with detailed drawing, are shown.

The Roughen Adjustable Paving Gauge is the subject matter of an interesting circular of the Roughen Adjustable Paving Gauge Co., Fond du Lac, Wisc. It illustrates and describes equipment used in highway work with one man propeller. It is claimed for the equipment that with it one man strikes off the base and the succeeding course and makes a uniform crown and thickness.

The Austin-Western Line, catalog No. 24, has just been issued by the Austin-Western Road Machinery Co., Chicago, Ill. This is an elaborate catalog, describing the entire Austin-Western line of road machinery, and is 9 in. x 12 in., with 64 pages, fully illustrated. The book is tangible evidence of the scientific painstaking development of new and improved road working tools.

The Plane-Tainer, the maintainer that works like a plane, is the title of a 4-page bulletin, issued by the Austin-Western Road Machinery Co., 8½ in. x 11 in., describing and illustrating the basic principle of the Austin plane-tainer, for securing and preserving a smooth, even surface without ruts and hollows.

Better roads and more of them for less money is a broadside describing the Austin Pup, of the Austin-Western Road Machinery Co. The Austin Pup is described as primarily a road maintainer, but, at the same time, is a three-wheel power roller of sturdy design and ample power.

The Austin Pup is further described and illustrated in a broadside under the heading *Can you afford to buy or operate an outfit of several machines on work that can all be handled by a one-man Austin Pup?*

The Western Patrol No. 1 and No. 2 are described in a circular, 9 in. x 12 in., giving complete specifications for these graders, which are new machines introduced at the Chicago National Good Roads Show for the first time by the Austin-Western Road Machinery Co., Chicago, Ill.

The Milcor Manual is a very elaborate data book of Milcor fireproof building products, issued by the Milwaukee Corrugating Co., Milwaukee, Wis. The book is issued as catalog No. 20, is 8½ in. x 11 in., and contains 64 pages with paper covers.

The data include engineering tables, details, specifications and general information regarding Milcor stay-rib and netmesh expanded metal lath, expansion corner bead and casings, steel domes, channels and other fireproof building products. Approved architects' specifications and index make the book complete for reference purposes.

The illustrations show, by a diagram and an actual photograph, the use of Milcor fireproof building products, as well as some of the processes involved in the manufacture of the products.

An illustrated booklet has been issued by the American Cement Machine Co., Keokuk, Ia., under the heading *Illustrated Specifications of Boss Tilter Batch-a-Minute Mixer*. Specifications for Boss two-wheel auto trailer mixer, low charging mixers, automatic power loading mixers, skid mixer for factory use and labor-saving attachments are covered in the booklet. It is 8½ in. x 11 in., with 8 pages.

Boss 2-in-1 Building and Paving Mixer is the title of a 4-page folder, 8½ in. x 11 in., issued by the American Cement Machine Co., describing and illustrating the 7-E Boss paver.

The Butler Batch Measuring Hopper, The Butler Equipment Co., Waukesha, Wisc. This equipment is intended for use under bins to measure fine and coarse aggregate. The manufacturers claim that with one man to operate levers, a single batch truck can be loaded in ten seconds, and a three batch truck in one minute. Hoppers are adjustable to the ordinary mixers required in paving.

Anchor Concrete Machinery handbook on concrete products machinery, Anchor Concrete Machinery Co., Columbus, Ohio. 8¼ x 10¾ in. 64 pages and cover in two colors. It is a very well-printed book; contains thoughtful general discussions on the whole concrete products industry in relation to the rapid development of the concrete building unit both in manufacture and in use; clear illustrations and detailed descriptions of the Anchor line of machinery, including equipment for the manufacture of block of several well known types, tampers, brick machines and light weight building tile. The catalog also lists the Multiplex chimney block machine, the Kent continuous mixer, the Blystone batch mixer, the Anchor drag elevator, Anchor roller bearing cars for block or brick and ornamental molds.

Milburn Welding and Cutting Apparatus is the title of a booklet issued by the Alexander Milburn Co., West Baltimore St., Baltimore, Md., describing the Milburn line of acetylene generators, compressing plants, welding generators, portable oxy-acetylene plants and other Milburn tools. The pamphlet is 3¼ in. x 6 in. and contains 24 pages with paper covers, fully illustrated.

The Milburn Light, a 3¼-in. x 6-in. booklet issued by the Alexander Milburn Co., Baltimore, Md., describes and illustrates Milburn carbide lighting equipment for contractors, railways, mines and quarries.

The mechanical details of the Milburn light are fully described and illustrated.

Aeroil Thawing Outfits and Torches is the title of a 4-page bulletin No. 34 issued by the Aeroil Burner Co., Inc., Union Hill, N. J. The Aeroil double burner thawing outfit and thawing torch are illustrated and described. The Aeroil equipment is recommended by the manufacturers for thawing in the plant or yard, for unloading cars quickly after frost or sleet and also for use in the repair shop for straightening buckets on conveyors and many other heating purposes.

Organizations

American Concrete Institute; Harvey Whipple, Secretary, 1807 East Grand Boulevard, Detroit.

American Concrete Pipe Association; M. W. Loving, Secretary, 111 West Washington St., Chicago.

American Engineering Standards Commission; Dr. P. G. Agnew, Secretary, 29 W. Thirty-ninth Street, New York City.

Associated General Contractors of America; G. W. Buchholz, Secretary, 1038 Munsey Bldg., Washington, D. C.

Associated Metal Lath Manufacturers; 123 W. Madison St., Chicago; Wharton Clay, Commissioner.

Building Officials Conference; Rudolph P. Miller, President, Fred W. Lumis, City Hall, Springfield, Mass., Secretary.

Iowa Cement Stave Silo Association; H. E. Kilmer, Secretary, Oskaloosa, Ia.

Iowa Concrete Products Association; Ross Dowell, Secretary, 405 Hubbell Bldg., Des Moines.

Mid-West Concrete Products Association; D. R. Donlen, Secretary-Treasurer, 4340 Marcy St., Omaha, Neb.

National Association of Manufacturers; John E. Edgerton, President; Henry Abbott, Treasurer; George S. Boudinot, Secretary, 50 Church St., New York City.

The National Concrete Stave Silo Association; W. G. Kaiser, Secretary, 111 West Washington St., Chicago.

National Crushed Stone Association; A. P. Sandles, Secretary, 405 Hartman Bldg., Columbus, Ohio.

National Housing Association; Lawrence Veiller, Secretary and Director, 105 East 22nd St., N. Y. C.

The National Lime Association; Mather Bldg., Washington, D. C.

National Sand and Gravel Producers' Association; T. R. Borrows, Acting Secretary, 903 Munsey Bldg., Washington, D. C.

Portland Cement Association; William M. Kinney, General Manager, 111 West Washington Street, Chicago.

Wisconsin Concrete Products Association; D. R. Collins, Secretary-Treasurer, Milwaukee.